

UNIVERSITA' CATTOLICA DEL SACRO CUORE

**Dottorato di Ricerca in
Modelli Quantitativi per la Politica Economica
ciclo XXI
S.S.D: SECS-P /02; SECS-P /05; SECS-P/06**

**A REGIONAL LABOUR MARKET MODEL FOR GERMANY
- AN ANALYSIS OF MACROECONOMIC SHOCKS AND
ECONOMIC POLICY VARIABLES**

**Tesi di Dottorato di: Simon Georg Fauser
Matricola: 3480075**

Anno Accademico 2008/09



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Anno Accademico 2008/09

to my wife and my parents

*“The whole of science is nothing more
than the refinement of everyday thinking.”*

Albert Einstein (1879-1955)

Summary

This study deals with the reaction of labour markets to macroeconomic and economic policy shocks with reference to a number of characteristic Federal States of Germany.

The general aim of this research is to reveal structural settings of regions and to analyse the impact of economic policy measures on labour markets. The labour market model we develop could further be used as a tool for policy decisions. The proposed model builds on existing approaches such as Baussola (2007) and extends those by incorporating aspects of innovation as well as the institutional and political setting. The structure of the model, we develop, is unique in the German context, as it allows - by including aspects of innovation and the national institutional setting - for structural comparisons of regions beyond national boundaries!

The analysis builds on data from five major sources: regional accounts RA (2007) data and national accounts data SBA (2000 & 2008), annual household survey data MIK (2008), data from Research Institute of Occupation and Labour Market data IAB (2008), Regional Statistical Office data SLA (2008) and Centre for Economic Performance data NIC (2006). Further descriptive data stems from the Foundation for German Science, Grenzmann & Kladobra (2006). Together we have obtained a comprehensive data set on a NUTS 1 level with yearly data from 1975 to 2005.

Before constructing the labour market model, we deal with two aspects: First, we review the four standard approaches of macroeconomic modelling in order to decide which form fits our aim of modelling exogenous economic and policy shocks most adequately. We review, hence, the large-scale macroeconomic models, dynamic stochastic general equilibrium (DSGE) models, unrestricted vector autoregressive (VAR) models and structural cointegration VAR models. Based on their advantages and shortcomings we choose the VAR approach as being most adequate for our “shock exercise”. Second, we review the theoretical background of employment and unemployment as a basis for asking the question of how we should interpret the reactions of our model variables to the simulated shocks. We extensively use the NAIRU model (Franz, 2006) to study the driving forces and mechanisms of employment and unemployment. As to our extensions to standard modelling approaches, we also discuss the role institutions play. By reviewing innovation theory, we further provide an adequate basis for the proposed labour market model.

Having a solid understanding of the form and the phenomena that are fundamental for constructing a labour market model, we look at our objects of study. We present key economic indicators of Germany and choose the three Federal States Baden-Württemberg, North Rhine-Westphalia and Schleswig-Holstein for our analysis. With their diverse economic structures and geographic locations- minimal spill over effects among others-, these three States (Laender) are good representatives of all ten Western German Laender. The descriptive exercise provides an important finding: The divergence in wealth between Baden-Württemberg and the other two Laender, North Rhine-Westphalia and Schleswig-Holstein, only slightly emanates from higher employment inputs, like higher labour force participation or a higher employment rate in Baden-Württemberg. The crucial factor for the lead of Baden-Württemberg is higher labour productivity that stems from a bigger effort in innovation especially in highly innovative industries. This finding confirms the importance of including an innovation or productivity variable in the labour market model.

In constructing the labour market model, we follow a modelling strategy that fills the gap between traditional regional models and supply-side as well as economic dynamic approaches. The model specification adopts an Error Correction Mechanism (ECM) and has the form of a simultaneous equations model; ECM captures dynamic issues while incorporating long-term relationships. This serves our goal of providing a model revealing long run relationships while also being applicable for modelling economic shocks and policy decisions. The structure of the labour market model comprises three major blocks that endogenously determine the unemployment rate: The first block, labour demand, comprises employees in industry and services disaggregated according to their degree of innovation and knowledge intensity. Labour supply constitutes the second block incorporating the participation rate and self-employment. The third block consists of identities, based on sound economic assumptions that close the model.

We estimate the relationships on the labour demand and labour supply side with different estimation approaches. The different estimation approaches confirm the robustness of our model specification. The estimated relationships reveal that value added mainly drives labour demand and that wage costs have detrimental effects on employment in all Laender. On the labour supply side, in contrast, structural variables such as migration play a pivotal role. The estimates also reveal distinct differences in structural variables between the Laender, such as difference in sectors and branches as well as the Laender's dependence on long run trends. For the

simulation, the Mincer-Zarnowitz test as well as the Wald test only finds one significant case – at the 95% level- of overconfidence and 3 cases of too timid estimations.

Following these finding, the thesis investigates the reaction of the unemployment rate, labour demand and labour supply of the Laender to macroeconomic shocks in economic policy variables. Exemplary findings are: First, increasing union coverage leads to a consistent decrease in labour demand and also to decreasing labour supply, finally resulting in a lower level of economic activity, except in Baden-Württemberg from the medium term onwards. Second, the response to an increase in active labour market policy demonstrates the pivotal role the labour supply side plays for the labour market: A shock in active labour market policy leads to a decrease in the unemployment rate. This decrease, however, results from a substantial fall in the participation rate. A lower participation rate for the economy means a decrease in economic activity!

Having analyzed the findings of these two and the other shocks, we are able to formulate specific policy recommendations for each of the three German Laender. The general interpretation of the estimation results suggests that in Baden-Württemberg and Schleswig-Holstein the industry and the services sector show high employment multipliers. German and regional policies intended to foster industry are thus especially fruitful in these Laender. In North Rhine-Westphalia by contrast, high employment multipliers stem from the services sector only. A further finding is that labour demand depends more positively on value added than negatively on wages in all Laender and West Germany.

A further finding shows that the feedback mechanisms on the labour supply side take effect only about four or five years after the shock occurred but determine the development from then onwards. This means that for evaluating the effects of policy we have to allow for considerable reaction time.

Finally, this work points to an application of the model to regions of different countries.

In conclusion, the author develops a manageable macroeconomic, dynamic labour market model that reveals structural properties of the analyzed Laender. The author further tries to provide a tool for economic policy makers at a regional, national and international level for simulating policy decisions and revealing domains of promising policy actions through detecting the structural composition of regions and their response to shocks during the course of time.

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List of Abbreviations

B	Billion
BW	Baden-Württemberg
CGE	Computable General Equilibrium
DE	Germany (West)
EC	European Community
ECM	Error Correction Mechanism
EU	European Union
GDP	Gross Domestic Product
GEM	Global Economic Model
ILO	International Labour Organization
IMF	International Monetary Fund
KIS	Knowledge Intensive Services
LD	Labour Demand
mio	Million
NACE	Statistical Classification of Economic Activities in the EC
NAIRU	Non-Accelerating Inflation Rate of Unemployment
NUTS	Nomenclature of Territorial Units for Statistics
NW	North Rhine-Westphalia
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Squares
QUERU	Quasi Equilibrium Rate of Unemployment
R&D	Research and Development
RESID	Residual
RMSE	Root Mean Squared Error
SH	Schleswig-Holstein
SUR	Seemingly Unrelated Regression
TFP	Total Factor Productivity
TIC	Theil's Inequality Coefficient
UN	United Nations
VAR	Vector Auto Regressive
WS	Wage Supply

Introduction

When in 2000 the European member states set up the Lisbon agenda, the economic and political complexity in the EU has risen dramatically. With the accession of 12 states in 2004 and 2007, the EU now comprises 27 member states. Besides the integration of the new members, from 1999 onwards, also 12 - now 16-member states have experienced a deeper integration brought by the introduction of a single currency -the Euro. Increased integration has also led to an increased impact of national as well as European policies on a regional level. In addition to the increased integration in Europe, global trade and competition has increased within the most recent years. Consequently, the relevance of innovation has become essential for a region's competitiveness. Regional governments have gained in importance as competition between regions increased. Less competitive regions struggle with problems of high unemployment and are particularly affected by macroeconomic shocks. Macroeconomic shocks increasingly affect the regions as national boundaries and regulations diminish. The diverse effects and influences can be particularly well observed in Germany, at the centre of Europe, with federal states showing distinct differences in economic activity, sectoral composition, unemployment rates, and level of innovation as well as openness to international trade.

The complex situation requires tools for policy decision makers at regional, national and supra-national levels that are able to capture dynamic aspects and simulate policies.

Such tools should help reveal relationships between core variables and show how different regions react to the same policy or macroeconomic shock.

At the national and supra-national level large econometric models have been and are still utilized for impact analysis from central banks (Bank of Italy, 1986), government research units (Fitz Gerald, 2002) international organizations (IMF, 1998), the European Commission (Roeger & Veld, 1997), bargaining parties and many other institutions (Pesaran *et al.*, 2004). Such econometric models still widely use national specifications. Specifications for models on a sub-national level have only developed in recent years.

The focus of the present work lies at constructing a macro econometric model of the labour market for characteristic German federal states. The model helps in

understanding the diverse labour market conditions and their reactions to policy as well as economic shocks. The reactions to shock help determine whether different reaction patterns among the states exist according to their level of innovation.

The thesis comprises six chapters. We initiate **Chapter 1** with a review of macroeconomic models for economic policy analysis. After sketching the historic development over the last decades, we focus on the development in the geographical dimension of such models. Paragraph 1.3 then summarizes the four major approaches. The last two paragraphs of the first Chapter deal with empirical applications of macroeconomic models worldwide and specifically in Germany.

The **second Chapter** provides the theoretical background for the labour market model. It presents the theory of unemployment from the Classical and Keynesian models to the more recent models of the QUERU and NAIRU. We utilize the QUERU and NAIRU models as vehicles to point at major causes for unemployment such as shocks, wage rigidities, hysteresis, institutional influences or mismatches. The second part of Chapter 2 provides the theoretical background for the phenomenon of innovation and technological progress. A discussion of central thoughts in examining the relationship between innovation and the labour market constitutes the third part of Chapter 2.

Chapter 3 provides the empirical basis for understanding the economic structure and development of three characteristic German federal states. This serves as background information of our units under study. Key figures on Germany initiate the chapter. We then explain why the three chosen states are ideal for the following analysis. In the following, we decompose the most widely used measure for competitiveness and wealth GDP/head in its composites. When examining the composites we provide data on three points in time – 1975, 1991, 2005- and look at the ratios between the federal states. Besides the comparison between the federal states, we confront their values and ratios to the Western German average as a benchmark. The values and ratios provide insights in wealth, labour input- measured in hours worked and employment / unemployment as well as the participation rate, and measures of labour productivity and innovation. At the end of Chapter 3 the states' performances in the distinct measures, their sectoral structures as well as the development over time becomes clear.

Chapter 4 comprises information about the utilized datasets and variables. At the beginning, we explain why we opted for the NUTS 1 (nomenclature of territorial units for statistics) level as geographic level of analysis. Collecting data at the NUTS 1

level did not make data collection an easy task. As no comprehensive data set for all variables has existed, we have collapsed various data sets and manipulated data in order to estimate a properly detailed labour market model. A table with variable's meaning and sources completes the chapter.

Based on the modelling background of Chapter 1, the theoretical underpinnings of Chapter 2, the descriptive knowledge of Chapter 3, the knowledge about data of Chapter 4, we construct a labour market model in **Chapter 5**. We first review main existing approaches of econometric models specifically targeted at the approach we use in our model. Within the framework of the modelling strategy and philosophy, we develop the “rules” to which our specific model complies. Baussola (2007) offers a specification that suits the data well and enables us to incorporate dynamic issues important for the shock exercise in Chapter 6. Our specification follows his structure as a general guideline and extends it by incorporating policy variables differentiating between different levels of innovation and applying the same labour demand specification in industry as well as in services on a regional level. The model constitutes of a labour demand, a labour supply block and takes the goods market as exogenous. In total, the model comprises six equations and five identities. It uses an error correction representation for each of the simultaneous equations. After the model definition in part one, OLS and SUR estimation of the model constitute part two of Chapter 5. Both estimation techniques have been utilized to allow for testing the model's sensitivity to the estimation method. The choice of SUR estimation in addition to standard OLS estimation follows a positive test on dependence between the states and the finding of Barbieri (2007) that OLS and SUR estimates yield the best results in such an analysis. On the labour demand side, aggregate demand in industry and aggregate demand in services is estimated. On the labour supply side, the participation rate and self-employment are estimated. The chapter further reveals a better structural fit of the SUR opposed to the OLS estimation.

In **Chapter 6**, we present a dynamic deterministic simulation of the model based on OLS as well as SUR estimates. The fit of reproducing the endogenous variables is evaluated by Theil's inequality coefficient and the root mean square error. Only deciding upon these measures would favour OLS instead of SUR specification for the shock exercise. The visual inspection of the state's OLS residuals, the Chi² test and the inspection of dependencies of the endogenous variables on their lagged values, however, leads us to favour the SUR opposed to the OLS methodology for the shock exercise. Main sources of adjustment mechanisms to shocks and the

methodology are presented before carrying out the shock exercise. We model each shock once upon a time by an increase of 1% in the shock variable. The shocks comprise value added shocks, labour cost and product price shocks, innovation (productivity) shocks and three policy shocks. We follow the development of the three Western German states and the Western German average for 15 years after the shock. The chapter ends by describing observed regional reaction patterns to the modelled shocks.

Conclusions, data appendix and bibliography complete the thesis.

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1. Macroeconomic and Macroeconometric Models for Economic Policy Analysis: The Framework for Regional Labour Market Studies

The aim of Chapter 1 consists of providing the general macroeconomic framework for the labour market model we use in analysing regional labour markets. We shall start with a general description of main economic thoughts beginning in the 1960s. Paragraph 1.2 adds the development in geographical space macroeconomic modelling experienced, before paragraph 1.3 shows the four major macroeconomic approaches generally used. Building on these main approaches paragraph 1.4 presents worldwide empirical applications and 1.5. applications to the German economy.

1.1. General developments of macroeconomic models in the last decades

In the 1960s and 1970s, macroeconomic models have been widely used as tools for policy analysis. Their main contributions consisted in evaluating different possible scenarios and by their result giving advice to the policy maker in constructing policies supporting stable and continuous economic development. At that time economists constructed large-scale disaggregated models for policy analysis. A good example of such a model provide Duguay & Longworth (1998) in their first chapter when reviewing macroeconomic models and policy making for the case of the bank of Canada. The economic thought of Keynes was very popular at the time. Müller (1997) provides one example for the popularity of Keynesianism in the 1970s. He analyses macroeconomic modelling in a framework of imperfect goods and labour market. In such a framework he argues that following Keynes a change in money supply would affect real output and employment.¹

¹ The reason for this behaviour has been and still is that changes in money supply affect nominal wage/pricy elasticises which in turn can influence real variables such as labour demand or labour supply. We will discuss the role of price/wage rigidities in Chapter 2.1.5.

These early macroeconomic models came into problems, however, in forecasting the response of economies to major macroeconomic supply shocks as the oil crises or real wage rigidities.

Criticism came from the advances in econometrics theory (time series and panel data analysis) at the beginning of the 1970s. The **Lucas (1976) critique** is one of the most recognized that at its core criticized the use of large-scale macroeconomic models for not taking adequately into account the impact of policy on people's expectation. Typical models following Lucas – the so-called new neoclassical models – are based on dynamic, intertemporal optimization decisions by firms and households. As side conditions, they contain rational expectations of individuals and permanent market clearing assuming totally flexible prices. As an example, we refer again to Müller (1997). In neoclassical economics, he argues, an anticipated increase in nominal money supply by households and firms would- in contrast to the Keynesian thought- not have any real effects, not even in the short run. The totally flexible prices and wages would be nominally affected only. Only unanticipated changes in nominal money supply would affect real output and employment. Lucas even declared in his article the death of Keynesian economics: “One cannot find good, under-forty economists who identify themselves or their work as ‘Keynesian’. Indeed, people often take offense if referred to as ‘Keynesian’. At research seminars, people don’t take Keynesian theorizing seriously anymore; the audience starts to whisper and giggle to one another. (Cited from Mankiw, 1992, 559)”

Further criticism to macroeconomic models at the time arose at the beginning of the 1980s. **Sims (1980)** criticized the traditional Cowles Commission approach (Epstein, 1987) and called the restrictions in the short-run dynamics ‘incredible’.² He proposed instead the use of vector-autoregressive (VAR) models and thus, the inclusion of lagged variables in the estimation approach. Besides the advances in model construction, also the reincarnation of Keynesian theory contributed to model advancement in the 1980s. The change in assumptions was the rejection of perfect

² The traditional Cowles Commission approach represented a simultaneous equations estimation procedure for the parameters of a system. In order to facilitate the estimation, assumptions had to be made about the nature of the system. The restrictions mainly dealt with restrictions on the covariance matrix of the error terms and the parameters in the estimation matrices. In contrast, in the Cowles Commission approach, the covariance matrix of the error terms was left unrestricted and only the parameters on the estimated matrices had to be at least zero. Consequently, this often meant that enough lagged values were omitted from the system to identify the coefficients attached to the endogenous variables remaining in the equations.

markets. In imperfect markets, the Walrasian auctioneer³ was substituted by the price setting behaviour of the players such as unions and employers. The economic players transformed from price takers to price setters. This assumption enabled deriving nominal as well as real price and wage rigidities from the optimization behaviour of firms and households. For the example of Müller (1997) this means that a change in money supply only impacts on employment if nominal or real wage rigidity exists. An example for such rigidity involving behaviour is the industry union.

A third criticism came from empirical application of the developed models. The non-stationarity of macroeconomic variables (Nelson & Plosser, 1982) called for consideration of the problem of spurious regression (Yule, 1926; Champervorne, 1960; Granger & Newbold, 1974).

Besides these developments in econometric theory, model building and advances in underlying assumptions, also the geographical focus of macroeconomic models changed over the last decades. Paragraph 1.2 presents these main changes, before paragraph 1.3 contains resulting approaches in macroeconomic modelling based on the developments in this and the next paragraph.

1.2. Developments in the geographical focus of macroeconomic models

One difference to the large-scale disaggregated models of the 1960s was the application of smaller, more focussed models from the 1970s and 1980s onwards. The more focussed models could be more adequately used for both policy analysis and economic projections. Smaller models applied besides a reduced number of variables also a smaller geographical unit. National models were transformed into regional models, or state models, as the investigation of distinct regional differences in economic variables gained importance. Examples are Adams *et al.* (1974) and Glickman (1977). The shift from national towards regional models can be attributed to better data availability and to the increasing trend of globalisation. At the beginning economists, constructing regional models followed the approach of the former national models. Their approaches were based on small, open economies of IS-LM type general equilibrium models. The inclusion of wage equations allowed for

³ Walrasian auctioneer is an auctioneer that sets the price perfectly, so that total demand across all agents equals the total supply of goods (see Walras, 1874)

wage determination and consequently modelling unemployment was possible.⁴ More recently, the role of supply side economic factors from regions gained in importance. Different educational levels of a regions population or different institutional setting are just two examples of this development. With increasing turbulence in some sectors of the economy, the role of adjustments mechanisms to reach an equilibrium level became another pivotal point for discussion. Economists reacted in using co-integration and error correction models (ECM) for regional modelling. Regional modelling also gained from the new growth theory and the empirical convergence controversy. The question of how regions can achieve sustainable long run growth and whether they converge towards the same economic level of activity in the long run are two questions resulting from these economic thoughts.

A further development in the geographic context is that of the inclusion of a geographic index on variables. In so-called spatial econometrics models, the time series or panel data variables are all equipped with an index indicating their geographic location. With this development, economists recognize the dependence of economic investigation on space. The effect of an economic shock in a large region might be very different from a shock in a small region. Moreover, the effect might not only depend on the size of the region under observation but also on its distance in a geographic or informational sense to its neighbouring regions. Thus, including an index capturing the geographical derivation makes sense in models of spatial econometrics. A recent example of such a model provides Fingleton (2001) who observes the dynamics of European regional convergence in a spatial econometrics model. He computes simulations using a computable geographic equilibrium model. Freeman (2001) provides another example of a regional model. He observes the development of employment and population in the US regional growth process. He uses panel co-integration techniques and causality tests to solidify his model. He underlines the importance of both, the demand side- export driven- and the supply side – depending on the regional amenities- for the regional growth process.

Based on the description in paragraph 1.1 and this paragraph we now turn to the modelling approaches resulting from these developments.

⁴ Bolton (1985) presents an excellent review of the structure of such typical models at the time.

1.3. Resulting approaches for macroeconometric modelling

Again, the developments described in paragraphs 1.1. and 1.2 lead to different approaches in macro econometric modelling. Like Barbieri (2007) emphasized in her macroeconometric study^{5,6}, the four main approaches are a) large-scale macro econometric models; b) dynamic stochastic general equilibrium models; c) unrestricted and structural VARs; d) structural cointegration VARs.

a) The **large-scale macroeconometric models** follow the tradition of the previously criticized Cowles Commission (Epstein, 1987). However, advances to previous models constitute the strength of large-scaled Macroeconometric models. Advances are a strong distinction between exogenous and endogenous variables, restrictions to achieve identification, estimation by least squares or by instrumental variable methods. Examples are the HM Treasury's model of the U.K. economy (IMF, 1998) as well as the Federal Reserve Boards model of the U.S. economy (Brayton & Mausekopf, 1985). Shortcomings are the huge amount of data required and the big complexity of the models.

b) **Dynamic stochastic general equilibrium** (DSGE) models (Kydland & Prescott, 1982; Long & Plosser, 1983) closely relate to the typical methodology stemming from the Real Business Cycle literature.⁷ Recent developments describe the models strength in incorporating nominal effects, adjustment costs, heterogeneity and endogenous technological progress. Shortcomings are that they do still not allow for real factors like productivity shocks and tend in their structure towards the traditional macroeconometric models. The similarity to other modelling approaches (Kim & Pagan, 1995; Christiano *et al.*, 1998) also manifests the fact that restricted VAR models can approximate DSGE models.

c) **Unrestricted VARs** are a consequence of the Sims (1980) critique on large-scale macroeconomic models. Examples are Doan, Litterman & Sims (1984) and Litterman (1986). Their smaller and more manageable model specification is certainly their biggest strength. The manageable model specification allows the unrestricted VARs to investigate the dynamic response of the system to shocks. In contrast to the large-scale macro models, the unrestricted VARs rely exclusively on time series

⁵ See Barbieri (2007, 24-26).

⁶ Macroeconometric models describe the economy quantitatively, rather than qualitatively.

⁷ In the Real Business Cycle literature the intertemporal general equilibrium is based on optimizing households and firms.

observations for feasible restrictions. Further strength of this approach lies in forecasting and serving as benchmark for evaluation of DSGE models. Shortcomings comprise the less usefulness for policy evaluation and the need of resort to economic theory when constructing the model (see Pagan, 1987).⁸ The approach is unfeasible to add to the explanation of economic dynamics that is a further shortcoming.⁹

d) **The structural cointegration VAR** models try to overcome previous shortcomings in fitting time series data and behavioural relationships of macroeconomic theory by flexible dynamics. Based on macroeconomic theory a long-run cointegrating relationship between the variables in the model is defined. This approach follows the hypothesis of a unit root for all economic series. As a next step, deviations of the long-run relations from their realized relations (*long-run structural shock*) are added. Then *long-run reduced form shocks* are derived, as not all variables following the macroeconomic theory are observable. The long-run reduced form shocks are based only on the observable variables and expressed in terms of the long-run structural shocks. Integrating the long-run reduced form shocks into a cointegrating VAR model yields a well founded intelligibility for the structural long-run relationships. The model has its advantage in impulse-response analysis as well as forecasting in the medium run. In testing for cointegration and restrictions on the long-run relations (Johansen, 1995; Pesaran *et al.*, 2000; Pesaran & Smith, 1998) further adequate restrictions are imposed on the intercepts and / or the trend coefficients in the VAR. Shortcomings are that finding feasible restrictions based on cointegration is sometimes impossible from a technical point of view.

The review of four major approaches in economic modelling has shown that every approach has its strength and its shortcomings. Considering all approaches together, we consolidate that macroeconomic modelling besides all criticism remains important as tool for policy analysis. The next paragraph provides some applications of the discussed modelling approaches.

8 Examples of the resort to economic theory in models construction are data transformation to achieve stationarity, the variables included in the VAR analysis, the Cholesky decomposition of the variance-covariance matrix.

9 Alternatively to the unrestricted VARs approach, Bernanke (1986), Blanchard & Watson (1986) and Sims (1986) proposed the structural VARs approach. Identification in this approach is achieved by a priori restrictions on the covariance matrix of the structural errors and / or on long-run impulse responses. A major problem with this approach is that the number of covariance restrictions ' $m(m-1)/2$ ' increases rapidly with the number ' m ' of variables in the model.

1.4. Worldwide applications of macroeconometric modelling

The large-scale macroeconomic models applied today often consist of combinations of former approaches. They are called global forecasting models¹⁰ pointing at the fact that the former large-scale macroeconomic models for a national level have been developed for a trans-national context. Most of them build on theoretical underpinnings while using calibration methods to fit the structure of the underlying data. By nature, they are more closely linked to theory based CGE models than VAR model and hence are especially useful for long run scenarios and less useful for short run analysis. Some important examples are the Lawrence Klein's project Link adopted by the United Nations, the NiGEM of the OECD (Barell *et al.*, 2001) and the 'MULTIMOD Mark III Econometric Model' of the IMF (IMF, 1998). A current example represents the QUEST III (Ratto *et al.*, 2008). Its focus lies on the Euro area and can be considered as a tool for fighting the current financial crises. It represents a tool for stabilisation policies¹¹ with respect to fiscal and monetary policy. QUEST III is an estimated dynamic stochastic equilibrium (DSGE) model of the euro area. Besides these global models, also models that focus on a limited number of countries or regions have been constructed. Such models focussing on a selection of countries or regions provide important insights into international connectedness, international dependence and are particularly useful in forecasting. A popular application of such approaches is the so-called triad: The U.S., Europe and Japan. Rae & Turner (2001) provide such a small forecasting model of the triad.

Examples in the field of structural cointegrated VAR models are King *et al.* (1991) who set up a six-variable model for a small closed economy. Mellander *et al.* (1992) present another small but specific model that captures the open state of the Swedish economy by only four variables. Their model builds upon the well-known consumption-investment-income model by King *et al.* (1991) and extends this approach by adding a term of trade variable to capture the international connectedness of the Swedish economy. Garratt *et al.* (2003) develop a core U.K.

¹⁰ See Barbieri (2007, 26-28)

¹¹ The general discussion about whether macroeconomic policy as such has the power to improve the performance of the economy goes beyond the current work (see Romer, 1986). Looking at the huge financial effort states are exerting in the current financial and economic crises, may be in two years from now we have further empirical data to analyse in addressing this question.

model using quarterly data from 1965 to 1995 and apply a similar model than the previous ones for impulse-response analysis and probability forecasting.

Besides such applications to single, small open economies Pesaran *et al.* (2004) construct a cointegrated VAR model able to forecast a core set of variables for 25 countries. They cluster the 25 countries into 11 regions and implement their global VAR model (GVAR) using quarterly data from 1979-1999. The advantage of such a framework comprises identifying national and international factor and regional interdependencies. The GVAR methodology is also heavily used in new economic geography (Krugman, 1993; Fujita *et al.*, 1999), regional and urban economics (Voith, 1998; Henderson, 1988; Solé-Ollé, 2004) and labour mobility (Blachard & Katz, 1992).¹²

Besides international models, also many sub-national models are applied. Many regional models are used for regional forecasting and typically exploit time-series econometrics. They often focus on industrial structure and consider intersectoral links while modelling each region separately. Examples of such regional models are Magura (1998), Mayor *et al.* (2007) and Patuelli *et al.* (2006).

Summarizing we can state that a modelling approach might match more or less the pursued goals (Pesaran & Smith, 1985, 1995). However, it is very unlikely that a single model approach can suit all purposes (Whitley, 1997).

We now turn to applications of macroeconometric models in Germany, as the later proposed labour market model will also be applied in a German context.

1.5. Applications of macroeconomic modelling in Germany

The “Bundesbank” model for the German economy (Deutsche Bundesbank, 1994) has been developed from a single country model into a multi country model, the MEMMOD- macro-econometric multi-country model. The Bundesbank acknowledges with this development the increasing importance of international linkages. The MEMMOD (Deutsche Bundesbank, 2000) is a macro-economic model based on solid theoretical foundations. In its structural form it follows neither a

¹² The GVAR modelling approach utilizes panel data. Econometric theory for panel data is widely developed only for the case where a big number of individuals are analysed only for a small number of observations in time (often only four or five). If now the time dimension of the panel data is large, panel cointegration methodology has to be applied which is just about to be developed.

CGE¹³ nor a VAR¹⁴ modelling approach but incorporates long-run relationships as well as short run dynamics by an error-correction specification.¹⁵ The model consists out of 120 equations for Germany and 60 equations for the other economies. Most equations are estimated using OLS¹⁶, only very few are estimated by non-linear least squares. Estimation is based on quarterly data, which normally range from 1975 to 1997. The model aims at analyzing fiscal and monetary policy and shall serve as a tool for policy analysis and forecasting. It tries to overcome the shortcomings of CGE and VAR model and aims to be applicable for short as well as long run analysis.

Von Borstel (2007) discusses another interesting macroeconomic model from the Bundesbank. She sets up a dynamic disaggregated GVAR model with 28 equations and applies it to seven German industry branches.¹⁷ Using OLS, she estimates the equations with quarterly data from 1991 until 2006. The model is used to analyze sector-specific reactions to macroeconomic shocks, in the short to medium run.

German regional modelling mainly uses the Federal States level or the district level. A recent example provides Schanne *et al.* (2008). They forecast unemployment rates of 176 German districts¹⁸ in a univariate spatial GVAR model using monthly data from 2004 to 2006. The estimation method is OLS and the time focus is short to medium run.

Following the indications in constructing a macroeconometric model of the labour market so far one has to decide between the analytical scope – short run or long run –, the geographical scope – national or international –, the level of aggregation – district, regional or national –, the methodological approach – theory opposed to data based – and consider the manageability of the model. Reaching an adequate decision requires first, however, a solid understanding of the functioning of the labour market, the phenomenon of unemployment and the relevance of innovation theory in this context.

¹³ Computable General Equilibrium

¹⁴ Vector Auto Regressive

¹⁵ In our proposed labour market model, we also follow this modelling approach and adopt an error correction specification, see Chapter 5.1.

¹⁶ Ordinary Least Squares

¹⁷ The proposed labour market model in chapter five also disaggregates the total economy into sectors.

¹⁸ The size of the districts lies in between NUTS 2 and NUTS 3 regions.

2. Employment Theory, Innovation Theory and their Relationship

2.1. Theories of employment and unemployment

“The function of the labour market is to bring together in an optimal way workers and jobs”
(Franz 2006, 3).

The particular character of the labour market implies that a vast number of players influence its optimal way. These players include every single man and woman deciding whether to work or not, every employer deciding whether to hire a worker or not. Besides these fundamental decisions of the worker and the employer other players such as the policy maker or the consumer play an integral role in shaping the conditions in which the worker and the employer reach a decision.¹⁹ The sheer number of agents involved in shaping the **labour market** makes its **condition** an issue of high priority for modern societies. “The condition of the labour market decisively defines who and to which degree an individual takes part in the economic well-being of a society. Unemployment impacts on individual income, the level of supply of households and reduces social appraisal of those excluded from the labour market” (Abraham & Hinz 2005, 11).

The malfunction of the labour market - expressed in the phenomenon of unemployment - hence creates problems that transcend the mere economic. Unemployment is a complex phenomenon with multiple causes and feedback mechanisms. Often movements in the terms of trade or effects of counter-inflationary demand policies can play an important role. Differences between countries can stem from institutional differences in the wage-setting process. An important role can be attributed to the propagation mechanism that makes temporary shocks to have permanent effects on unemployment. For the big European countries where high unemployment rates exist, it seems to be the case that the characteristics of the outsiders (e.g. people in the education system) have a

¹⁹ The policy maker impacts on the educational system, the matching process between labour demand and supply and the institutional setting of the labour market. The consumer determines with his individual decisions of consumption, aggregate demand of goods and services. The worker produces these goods and services under a working contract of the employer or as self-employed.

greater impact on unemployment dynamics than the characteristics of the insiders. This is supported by the fact that firing rates are often below re-employment rates. In general, decreasing unemployment permanently is a difficult task. Target areas in such an attempt comprise education, active labour market policies or marginal employment subsidies targeted at long-term unemployed.

The aim of this section is to **understand the phenomenon of unemployment** by looking at widely accepted theoretical concepts. We initiate with basic models of unemployment and focus on the factors influencing the unemployment rate within such models.²⁰ As a prerequisite, assumptions of imperfect competition in the goods and labour market are made. Systematically we develop the basic models and discuss key factors influencing the level of unemployment.

The classical model provides the starting point and allows only for voluntary unemployment. For Keynesian economists not only voluntary unemployment exists but unemployment is rather caused by rigid wages or an insufficient consumer demand for goods. If the cyclical demand for goods is not high enough, not enough workers are needed to produce goods and consequently some cannot find a job. As both models fall short in explaining long-term unemployment we consider a next theoretical model – the QUERU model- in paragraph three. The QUERU model provides a simple wage-setting and labour-demand curve framework in which prices are perfectly predicted and temporary shocks are ruled out by definition. The NAIRU approach extends the QUERU approach by discussing the conditions for inflationary-stable unemployment rates under the consideration of shocks. After the theoretical foundation of the NAIRU is sketched, exploring the main factors that influence the NAIRU makes up the chapter. The factors under study are shocks, wage rigidities, hysteresis, institutional influences and mismatch.

2.1.1. The Classical theory and the Keynesian model of employment

At first look, the phenomenon of unemployment²¹ seems to be of simple nature: Labour supply exceeds labour demand. Theoretically, the excess of labour supply

²⁰ Main theoretical foundations emanate from Layard *et al.* (1991), Phelps (1994) and Pissarides (2000).

²¹ There exist differences in the definitions and measurement of unemployment between countries. Freeman (1995) argued that low pay for the mere sake of statistically measured full-employment can be dangerous as it might provide an incentive for workers to embark on a criminal career.

over labour demand should be easily resolved. An unemployed worker would look around for a job that matches his notion of wage. In the case he cannot find a firm that offers this wage, he will reduce his wage until he finds a firm or until he reaches his reservation wage. If he does not find a firm before reaching his reservation wage, he decides not to work and drops out of the labour force. Hence, in the **classical model** only **voluntary unemployment** exists. Cahuc & Zylberberg (2004, 458) note: “the classical theory rests on the idea that real wage maintains the labour market equilibrium.” In addition, the classical model assumes perfect flexibility of prices. The perfect flexibility of prices leads to the fact that changes in aggregate demand have no – not even short-run- effects. Another feature of the classical model is the neutrality of money. Cahuc & Zylberberg (2004, 459) describe this classical dichotomy: “the real fundamentals of the economy – the tastes of consumers and the characteristics of production ... - determine real equilibrium ... independently of the quantity of money ...” The real equilibrium is influenced by shocks such as a positive shock in productivity which increases real wages and employment by reducing the price. On the other hand, a negative productivity shock or an increase in production factors such as the price of oil can lead to unemployment. Employment and output can be reduced by the market power of firms that realize high profits at the cost of employing fewer workers. Fewer workers are also employed because of all factors that raise wages. Such factors include taxes, ancillary labour costs, labour market regulations that reduce labour market flexibility or the biased bargaining behaviour of unions in favour of the employed at the cost of the unemployed.

One shortcoming of the classical model is that it does not explain involuntary unemployment. Furthermore, the classical model predicts too much volatility in real wages whereas empirical evidence points at the fact that employment strongly correlates with labour productivity. Christiano *et al.* (1999) reveals that changes in aggregate demand have real transitory effects whereas in the classical model changes in aggregate demand have no real effects.

Besides the classical model as a starting point for macroeconomic analysis, the **Keynesian model** constitutes a sound theoretical understanding of the phenomenon of unemployment. Contrary to the classical view, Keynes argues that the **state should interfere in markets** (Keynes, 1936). The best recipe against unemployment, he notes, is to strengthen consumption that leads to a higher demand of products and workers that in turn reduces unemployment. In the context of unemployment,

the Keynesian approach assumes that nominal wage is rigid in the short run and **unemployment** can occur as a lack of demand for goods— at least **in the short-run**.²² The **rigidity of wages** and their enduring adjustment contrasts the classical model of perfect wage flexibility. The process of wage adjustment is formalized by Phillips (1958), called the Phillips Curve. The Phillips curve describes the process of wage adjustment by the negative relationship between the rate of growth of the nominal wage and the unemployment rate. The original Phillips curve experienced some amendments over time to better match empirical data.²³ The first is the concept of the “augmented” Phillips curve, a Phillips curve that describes the relationship between a nominal change in wage, depending on the unemployment rate as well as on the inflation rate. Other explanatory variables have been included into the Phillips curve in order to describe the fluctuation in wage, experienced by many countries. Among these is the growth rate of productivity that in many countries is an important factor when firms and workers argue about the height of wages.²⁴ Irrespective of the modifications of the Phillips curve, the concept as such shows that the process of wage formation and the variables that affect this process are of central importance when analysing the phenomenon of unemployment.

The classical as well as the Keynesian model get into difficulty when explaining high long-term unemployment as observed in the big European countries over the last decades.

Therefore, the following models of the QUERU and NAIRU shall add to the understanding of how unemployment emerges and becomes persistent.

2.1.2. The model of the Quasi-Equilibrium Rate of Unemployment (QUERU)

The model of the quasi-equilibrium rate of unemployment (QUERU) is an approach to explain the **sources and persistence of unemployment**.²⁵ The

²² Nominal rigidity describes the degree of reaction of nominal wages because of changes in prices.

²³ An example of a specification of the Phillips curve can be found in the discussion of the NAIRU.

²⁴ For details on possible specifications, see OECD (1994, 1997) and Richardson *et al.* (2000).

²⁵ For a detailed discussion of the QUERU-model see Calmfors & Holmlund (2000), Franz (1996) and Lindbeck (1992, 1993).

QUERU is also called the “natural” rate of unemployment (Blanchard & Katz, 1997 or Landmann, 1989).²⁶

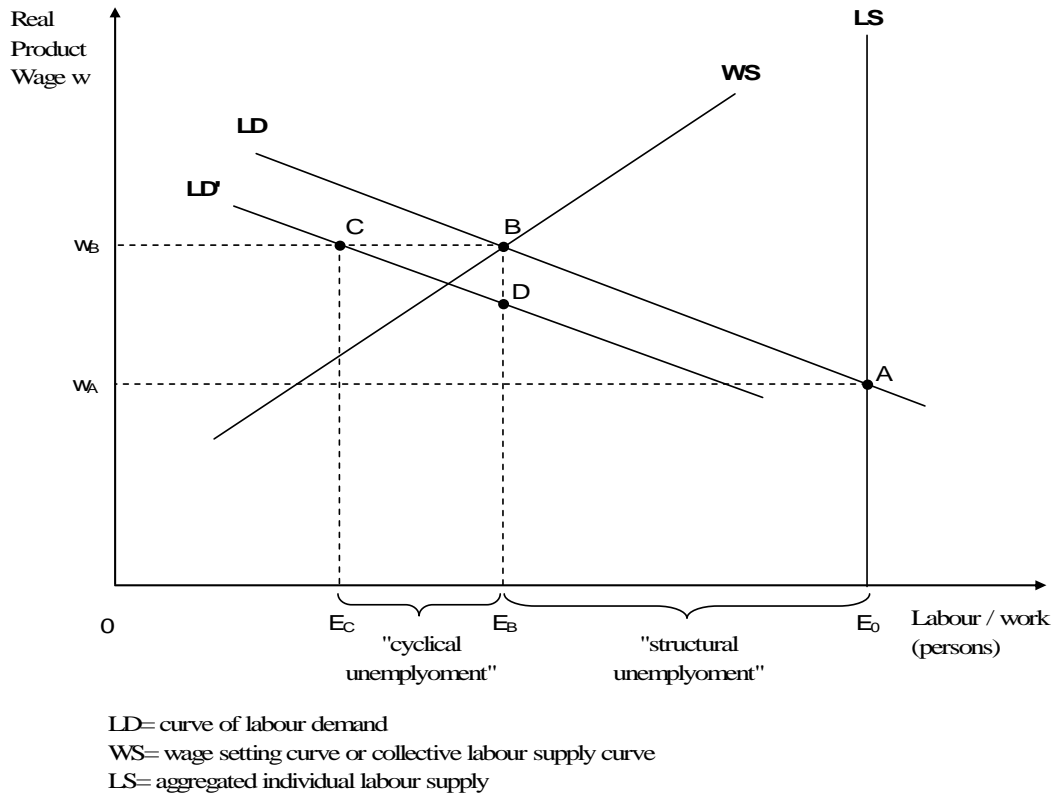


Figure 2-1: The QUERU theoretical reference model (source: according to Franz 2006, 375)

The model is a simple supply and demand model with labour on the x-axis and real product wage on the y-axis. According to Franz (2006) the downward sloping demand curve, LD-curve, represents the traditional labour demand function depending on product wage and other variables.²⁷ The upward sloping supply curve,

²⁶ The term “natural rate” of unemployment was introduced by Friedman (1968) and understood as the unemployment rate as a result of incomplete information during the search process. Weber (1995, 436) states: "...the natural rate of unemployment is the unconditional mean rate [...] the deviations from [...] [the] trends are used as estimates of the log output ratio and the cyclical rate of unemployment." The exactness of estimating the natural rate of unemployment is limited (see Staiger *et al.*, 1997)

²⁷ The demand curve shows a negative slope as the marginal productivity as well as the marginal wage of labour decreases, the more intensively labour is used.

WS curve, represents the wage setting behaviour.²⁸ Labour supply, LS parallel to the y-axis, is totally inelastic. The inelasticity reflects the simplifying assumption of constant labour supply. In the absence of collective bargaining, the real product wage would be only w_A where when wage bargaining systems are inherent, the real product wage lies higher at w_B . The difference between inelastic labour supply – LS- and the intercept point of labour demand –LD- , E_0 , and LD with the collective labour supply –WS-, point E_B , is called “structural unemployment”.²⁹ A shift in the LD curve to LD' -resulting from a lack in demand for goods, for example- leading to additional unemployment, between E_B and E_C , is called “cyclical” unemployment.. Fully rigid wages lead to a maximum of cyclical unemployment. According to Franz (2006), the QUERU model explains the phenomenon of unemployment with the help of the following **four hypotheses**:

A QUERU exists because of influences on the functioning of labour markets. These influences impact on labour demand and supply. For example, influences can take the form of inflexible systems of wage determination or insufficient incentives to accept a job. Incentives, wages and their determination lie at the core of the issue.

The QUERU has increased over time expressed by a shift to the left of the WS and/or the LD curve in the model. One reason for such a shift could be a loss in international competitiveness. An example for a shift of the WS curve could be the consequence of a generous unemployment benefit system.³⁰

The real unemployment rate differs from the QUERU because of frictional adjustments, shocks in the goods market and changes in labour supply. Typical supply and demand shocks on the goods market are reduced consumption, import price or technology shocks. An increase in worker participation is a typical labour supply shock. The pivotal question is how the labour market reacts to these shocks.

Differences of the real unemployment rate with respect to the QUERU can have long-lasting effects and finally lead to a change in the QUERU itself. The transmission mechanisms leading to a change in the QUERU are summarised under

²⁸ The supply curve shows a positive slope as, for example, the more labour is used the stronger the negotiation position of unions which tends to increase the real product wage.

²⁹ “Structural” unemployment comprises all factors resulting in the position and the slope of the LD as well as the WS curve. The term “structural” does not indicate that this part of total unemployment can't be changed. In the case of a high LD curve - caused by high factor prices like tariffs on raw material inputs- a reduction in tariffs would shift the LD curve up and reduce “structural” unemployment.

³⁰ Krugman (1994) provides a discussion about the impact of unemployment benefits on the unemployment rate.

“hysteresis phenomena”. Examples are increasing depreciation of human capital of the unemployed or the lack of an outsider to impact on wage determination.

Under the assumption of temporary supply shocks being zero and assuming that expectations about the development of prices meet the real development of prices³¹, the **QUERU** u^*_L can be represented – according to Beissinger (2003) - by the following:

$$u^*_L = b_0 + b_s S + b_x X \quad (1.1)$$

where b_0 is a factor accounting for influences of the level of prices and wages in relation to the impact of unemployment on the level of prices and level of wages; b_s is a factor comprising influences of institutional factors on prices and wages in relation to the impact of unemployment on prices and wages; similarly, b_x contains influences of persistent shocks on prices and wages in relation to, once again, the impact of unemployment on prices and wages; S accounts for institutional influences and X for the persistent variables of shocks. The equation shows that the QUERU can experience changes as expressed by the second hypotheses of Franz (2006)- due to changes in the institutional setting, S , or changes in persistent shock variables, X .

The QUERU model – in the treated form- does not account for unanticipated price changes - see the u^*_L conditions. Aspects of price development and inflation in relation to unemployment are the topic of the following chapter about the NAIRU.

2.1.3. The model of the Non-Accelerating Inflation Rate of Unemployment (NAIRU)

The concept of the QUERU and of the NAIRU- the non-accelerating inflation rate of unemployment- is strongly related.³² In the QUERU model, changes in wages and prices are always of the same magnitude. The magnitude itself can vary. In the concept of the NAIRU, the unemployment rate is calculated for a **constant increase**

³¹ Central bank policy supports this condition. The European Central Bank acts such that the inflation rate should not exceed an upper bound of 2% per year. Hence, ECB policy acts such that the real development of prices should match the expected development of prices- at least in a narrow bound.

³² Note that according to Franz (2003, p.1): “However, by any method, simple or complex, the NAIRU is very hard to determine and subject to considerable arbitrariness.”

in prices that is in fact a constant rate of inflation.³³ This is expressed by the terminology non-accelerating-inflation.

Next, examine the theoretical foundation of this assumption before modifying the QUERU and equation (1) to reflect the concept of the NAIRU. Assume that unions have negotiated a higher real wage. Now, the firm – in order to maintain its margin – increases the price of the same magnitude as workers' real wages increased. This puts pressure on inflation. As inflation goes up, unions negotiate higher wages and the wage-price spiral takes off. How can the wage-price-spiral be avoided? Simply by unemployment. Why? The higher unemployment, the lower the wage claims of workers. Moreover, the higher unemployment, the smaller the sales market for products and services of the firm. Hence, there must be a certain level of unemployment at which the wage claim of the union and price setting of the firm stabilize. This rate of unemployment with a constant rate of inflation is called the NAIRU.

For a formal approach of the NAIRU we extend the QUERU model. According to Franz (2006), the LD curve is now interpreted as the price-setting curve of the firms. The firms set their prices depending on labour input. Under the assumption of imperfect competition, firms set the price of goods applying overhead calculation to marginal cost of labour. As labour is used more intensively, marginal productivity of labour declines and consequently marginal cost of labour increases. With increasing marginal cost of labour, firms increase product prices by means of overhead calculation. Hence, there is a positive relationship between price and labour: The more labour that is employed, the higher the product price. The interpretation of the WS curve remains as the wage setting behaviour in the QUERU model. The NAIRU balances out the struggle for higher real wages on the workers' side and higher product prices on the firm's side. At each single moment in time, Beissinger (2003) explains, the NAIRU assumes static inflation contrary to the observed unemployment rate which experiences surprises in prices expressed as changes in the rate of inflation, or technically $(p-p^e)=\Delta\pi$, where p is the observed price level, p^e the expected price level, Δ the difference operator and π the rate of inflation. The **observed unemployment rate** u expresses as

³³ For a detailed discussion about the concept of the NAIRU see Franz & Gordon (1993) and Richardson *et al.* (2000).

$$u = b_0 + b_s S + b_x X + b_z Z - \frac{1}{\Theta} \Delta \pi \quad (1.2)$$

where the meaning of the additional variables to equation (1) is: Z is a temporary shock variable, b_z comprises influences of temporary shocks on wages and prices in relation to influences of the unemployment rate on prices and wages, and Θ equals the sum of the influence of the unemployment rate on prices and wages.

Layard *et al.* (1991) and Bean (1994) argue that the assumption of a static inflation rate can be made and is “rational” because empirical evidence shows that from the 1970s onwards the inflation rate can be approximated by a random walk process. This assumption allows building theoretical models of the empirically observed dynamics of inflation and unemployment.³⁴ In order to see the relation between the dynamics of the inflation rate and unemployment, we solve equation (1.2) for $\Delta \pi$ under consideration of equation (1.1) and get

$$\Delta \pi = \Theta(u_L^* - u) + \tilde{b}_Z Z \quad (1.3)$$

where $\tilde{b}_Z \equiv \Theta b_Z$. Equation (1.3) is the Phillips curve extended by expectations.³⁵ In the long run the temporary shock parameter $\tilde{b}_Z Z$ can be neglected and hence equation (3) shows that only the unemployment rate of the same magnitude as u_L^* leads to stable inflation. In contrast any difference between u and u_L^* leads to an increase or decline of the inflation rate. In the short run also the temporary shock variable can cause a change in the inflation rate. This change in the inflation rate can only be avoided by the so-called **shock-NAIRU** (see Franz, 2001). The shock-NAIRU is an unemployment rate that can be described by the following equation:

$$u^{Sh} = u_L^* + b_Z Z \quad (1.4)$$

If the observed unemployment rate is a shock-NAIRU and lower than the (long-run) NAIRU then the inflation rate remains constant. Examples of such favourable supply shocks are a decrease in raw material costs or import taxes.

Nickell (2003, 16) states: "The equilibrium level of unemployment is affected first, by any variable which influences the ease with which unemployed individuals can be matched to available job vacancies [see “*First*” and “*Third*” in the following sentences], and second, by

³⁴ In contrast to the described consistency of empirical evidence and macroeconomic theory - when imposing the assumption of a random walk process of the inflation rate -, theoretically well-founded micro models with rational expectations of the unemployment rate (the New-Keynesian Phillips curve) do have problems to be approved empirically (see Fuhrer, 1997 and Mankiw, 2001)

³⁵ For details about the extended Philipps curve see Friedman (1968) and Phelps (1967).

any variable which tends to raise wages [see “*Second*” in the following sentences] in a direct fashion despite excess supply in the labour market.”

Following the modified version of the QUERU, the following variables seem to influence the NAIRU. First, *temporary shocks* with permanent impact on the NAIRU. Studying supply shocks provides useful insights; second *the price setting behaviour* of workers and firms. Interesting aspects here are the level of wages and wage rigidities; and third *institutional influences*. Additional aspects are the phenomena of hysteresis and mismatch. Fighting unemployment, policy decision makers want to fight structural or long term unemployment, the long run NAIRU.

Hence, studying the **factors influencing the NAIRU** shall give us a better understanding of which factors the policy decision maker should target in order to alter the situation on the labour market.

2.1.4. The role of external shocks on unemployment

Among the few facts that are taken for granted among economists within the unemployment framework, is the fact that shocks³⁶ do influence the unemployment rate (see Blanchard & Wolfers, 2000 and Fitoussi *et al.*, 2000 or Bertola *et al.*, 2001). In the context of shocks, empiric and historic evidence, points at the unemployment increase in the OECD countries after the oil price shocks and the slow-down in total factor productivity (see Bruno & Sachs, 1985). This rise in the NAIRU can be shown by a modification of equation (1.2). Assume that there is no change in inflation and no institutional change as a shock occurs; the equation (1.2) can be rewritten into:

$u = b_0 + b_x X + b_z Z$. As previously written, the parameter b_0 is a factor accounting for influences of the level of prices and wages in relation to the impact of unemployment on the level of prices and the level of wages and can be specified as: $b_0 = (a_0^p + a_0^w)/(a_u^p + a_u^w)$. Combining the last two equations yields the following:

$$u = \frac{a_0^p + a_0^w}{a_u^p + a_u^w} + b_x X + b_z Z \quad (1.5)$$

Irrespective of whether the shock is considered a **temporary shock** or a **permanent shock** both would alter the NAIRU assuming that b_x and b_z are

³⁶ Factors that cause unemployment to deviate from its equilibrium level comprise according to Phelps (1994) aggregate demand shocks, productivity shocks and wage shocks.

unequal to and greater than zero.³⁷ If a shock hits the economy (expressed by an increase in X or Z) the NAIRU increases except the level of prices (a_0^p) or the level of wages (a_0^w) declines. In contrast, if the two sum operators of the denominator increase, unemployment can be reduced. They show the pressure of the unemployment rate on prices and wages. If this pressure increases – due to the higher unemployment rate after a supply shock - workers wage aspirations might decline, then firms may set lower prices and hence, the NAIRU can be reduced.

Looking at the NAIRU the simplifying assumption of no difference between temporary and permanent shocks was made. No differentiation is comprehensible if there exists a transmission mechanism that makes the temporary shock permanent.³⁸ The transmission mechanism could be the mind-set of the worker and firm that only change after a time lag. Other transmission mechanisms could be institutions, worker's education or company's methods of production.

2.1.5. Wage rigidities and hysteresis

So how do **wage rigidities** and the level of wages influence the NAIRU? As a starting point let us refer to equation (1.5). Recall that a_u^p is a parameter whose size determines the impact of the unemployment rate on the price a company sets. The higher the parameter, the greater the impact of the unemployment rate on the price-setting behaviour of the firm. In other words, only little unemployment is needed to put enough pressure on the price setting behaviour such that prices are set low. Comparably the parameter a_u^w determines the impact of the unemployment rate on wage aspirations of the worker. The higher a_u^w , the smaller the unemployment rate has to be in order to lead to moderate wage claims.³⁹ As these rigidities of prices and wages loop back on unemployment, they are made responsible for increasing and

³⁷ An example of a permanent shock provides Blanchard (2006, 39) who states: "[...] one of the reasons why the shocks of the 1970s and 1980s have led to high unemployment in some European countries today is that they triggered a change in institutions, which has been partly and poorly undone in these countries."

³⁸ Literature does not yet fully agree upon this concept (see Blanchard, 2000). Franz (2003, 9) notes: "No matter of the specific nature of these exogenous shocks, they give rise to a crucial distinction between a "shock-NAIRU" and a "no shock-NAIRU", depending on whether or not inflationary effects stemming from these shocks should be ironed out by higher unemployment."

³⁹ See Blanchflower and Oswald (1995) for a discussion about the impact of unemployment on the level of wages. For an estimation of a wage equation considering a relationship between the wage level and unemployment see Blanchard and Katz (1997).

persistent unemployment. Following Layard & Bean (1989) and Layard *et al.* (1991), the following **factors do theoretically explain** the phenomenon of **wage and price rigidities**: First, *incomplete information in search and contract theory*. Contract theory shows that it can be rational for workers to have a constant development of wages given a probability of being fired. Second, *efficiency theory and its transaction costs*. Efficiency theory tells us why it can be rational to have persistent unemployment and high wages.⁴⁰ Third, *the behaviour of insider to outsider in-wage bargaining* explains why unemployment can become persistent. The persistency of unemployment may arise because of a change in the wage bargaining conditions.⁴¹

All these concepts explain aspects of wage and price rigidities. They fall short, however, in explaining the initial reason of increasing historic unemployment.

The **hysteresis** phenomenon describes the idea that the equilibrium of a system depends on the path the system has followed to reach its current equilibrium. In the case of the NAIRU this implies that the long-run NAIRU would depend on the short-run NAIRU.⁴² Let us assume that an unfavourable supply shock hits the labour market. Therefore, *ceteris paribus*, the unemployment rate rises. This rise in unemployment leads to a subsequent rise of unemployment the period after and probably also in the next period. Even as the shock becomes a historic event, the NAIRU does remain on a higher level than before the shock occurred.⁴³ In order to see the linkages between the **hysteresis concept and the unemployment rate**, let us denote the difference in the unemployment rate of the current and the previous period as $\delta\Delta u = u_{t-1} - u$. Together with equation (1.3) we get:

⁴⁰ Persistent unemployment can discipline workers' working behaviour for instance. Akerlof and Yellen (1986) show that for a firm it can be adequate to pay a wage higher than the equilibrium wage.

⁴¹ Cahuc and Zylberberg (2004) note that the models of wage setting depend on the characteristics of the job held and the outside option of the worker. In a basic wage equation the wage resulting from the bargaining process depends on the reservation wage of the worker (which also depends on external factors like unemployment subsidy) and a markup as a result of the bargaining process. It is easy to see that if wage bargaining conditions change the markup will change. And as a result the bargained wage will change which *ceteris paribus* changes unemployment.

⁴² See Tobin (1972) and Stiglitz (1997) for figures of the NAIRU depending on the past unemployment rate.

⁴³ The enduring effect of the unemployment rate is expressed in incorporating the difference of the unemployment rate in the wage equation. See Franz (1996), Lindbeck (1996), and Pichelmann & Schuh (1997). An exemplary disadvantageous shock is disinflation. Hysteresis raises the sacrifice ratio of disinflation and leads to a loss in output even when the period of disinflation is over. For a discussion, see Blanchard & Summers (1988) and Ball (1997).

$$\Delta\pi = \Theta(u_L^* - u) + \delta\Delta u + \tilde{b}_z Z \quad (1.6)$$

It can be easily seen that for $\Theta=0$ (this means that the influence of unemployment on wages and the influence of unemployment on prices offset each other) and $\delta \neq 0$ there is full hysteresis. In contrast for $\Theta \neq 0$ and $\delta =0$ there is no hysteresis. Finally, for $\Theta \neq 0$ and $\delta \neq 0$ there is persistence. In the case of persistence, the change effect and the level effect matter and imply that a long period of unemployment leads to a higher NAIRU.

The reasons why a long period of high unemployment leads to a higher NAIRU are the bargaining powers of insiders (see Blanchard & Summers, 1986; Lindbeck & Snower, 1988), the depreciation of human capital because of a loss of skill or skill which becomes obsolete, the increasing discouragement of the unemployed and the effects that firms regard a long time of unemployment as a signal for negative worker's quality. Cahuc & Zylberberg (2004, 479) state: "Each transitory shock that increases unemployment does in fact increase the average duration of unemployment, and thus can durably reduce the average probability of re-employment. Job destruction and temporary increases in unemployment can thus have irreversible effects by excluding workers from the labour market."⁴⁴

In the case of persistence, however, an expansive policy aiming at a reduction of unemployment is capable of reducing the NAIRU by means of increasing the inflation rate. In the no-hysteresis case such a policy has no impact on the NAIRU.

Once policy decision makers decide upon a certain change in policy its impact heavily depends on the institutional setting carrying out the induced change in policy.

2.1.6. Institutional influences and the mismatch phenomenon

Based on rising unemployment rates in the 1970s and 1980s in France, Italy and Germany, and the decline in unemployment in the 1990s in Denmark, the Netherlands or Ireland, it seems to be insufficient to explain the development of unemployment by macroeconomic shocks only. Besides the price setting behaviour of the firm and the worker, the framework of the interaction – the institutional setting - also matters according to the neoclassical economists. According to North (1991) labour market institutions can be defined as formal and informal rules, which

⁴⁴ Cahuc and Zylberberg (2004) mention that the extent of the described phenomenon is not yet well established empirically.

steer the way agents act on the labour market. Blau & Kahn (1999) describe labour market institutions as the system of rules, programmes and conventions which impact on the labour market and cause that the labour market functions differently than a competitive market.⁴⁵

For the formal perspective, recall equation (1.2) in which the observed unemployment rate also depends on the institutional setting expressed by the variable S . The institutional influences comprise factors such as dismissal protection, taxes on labour (see Siebert, 1997), unemployment benefit schemes, active labour market policies but also the degree of organization of unions, and collective bargaining coverage. Nickell (1997) found among 20 OECD countries from the mid and late 1980s that the duration of unemployment benefits and the degree of coordination in collective bargaining were the most significant variables influencing the unemployment rate between countries. The influences decisively determine the **conditions under which the factor labour trades**. The price and flexibility of the trade of labour is heavily influenced by non-economic factors such as the education system and the central question of redistribution of a societies' wealth. Besides the terms of trade of labour, institutions influence the entry and exit of workers into and out of the labour market (see Mayer & Schöplin, 1989). The complexity of these influences and their mutual interference makes it until now impossible to establish a sound theoretical basis of the institutional influence on unemployment. Empirical studies point at the importance of institutional influences on unemployment; however, without a clear theoretical underpinning and contradictory findings they fall short in explaining the interactions between institutions and unemployment.

The theory of unemployment is not a theory of *the* unemployment and hence a potential **mismatch** between labour demand and supply can arise. In the adopted

⁴⁵ A number of theoretical and empirical studies (Calmfors and Driffil 1988; Bentolila and Bertola, 1990; Grubb and Wells 1993) highlighted the importance of rigid labour market institutions for European unemployment as Monastriotis (2006) notes. Not only differences between OECD countries' unemployment rate but also interactions and combination of institutions determine the level of unemployment: Stiglbauer (2006, 66) writes about the OECD jobs studies: "The OECD now concludes [opposed to their recommendations in the jobs study in 1994] that different combinations of institutions can promote a good labour market performance." It was found that labour market rigidities and institutions are associated with higher levels of unemployment, unemployment persistence, and longer unemployment duration, as Monastriotis (2006) notes (see Scarpetta 1996; Jackman et al 1996; Nickell 1997 and 1998; Nickell and Layard 1999). Obstfeld and Peri (1998) argue that besides the institutional setting, also housing prices impact on unemployment through labour mobility. For an overview and a critical discussion also see Baker *et al.* (2002)

macroeconomic perspective, we took the simplifying assumption of a single demand, a single supply and consequently a single unemployment rate. What many (advanced) economies experience today, however, is that **labour demand** and **supply** are increasingly **heterogeneous** in their structure. Therefore, even though quantitatively unemployment could be lower, mismatch of demand and supply leads to high unemployment. An observed example is vacant jobs for engineers while low-qualified workers experience low demand and high unemployment.⁴⁶ Main dimensions of the “mismatch unemployment” are qualification, geographical occurrence and information deficit. Information deficit describes the phenomenon that workers seeking a job do not know about available vacant jobs that match their qualification and geographic preference, or that firms are unable to locate matching workers to vacant jobs.⁴⁷ The geographic mismatch stems from the fact that neither worker nor capital shows entire mobility.⁴⁸ This leads to regional differences in unemployment.⁴⁹ The mismatch of qualification has various roots. In our theoretical model the impact of the mismatch is expressed by increasing wages. Simply because firms are unable to fill vacant jobs, they increase wages offerings for workers who match the job. The fewer workers match job requirements the higher companies have to set prices to compensate for higher wages. Higher prices increase inflation and hence, increase the NAIRU. As previously mentioned, this leads to a wage-price spiral that is balanced out by increasing unemployment.⁵⁰

⁴⁶ de Koning *et al.* (2004) investigate policies for employment and compare British, Danish and Dutch experience in how to create more employment. Their starting point - opposed to many economists - is labour supply instead of labour demand. They show that the vacancy rate of France, Germany and Belgium increased - especially in the 1980s- and that today these economies have the highest vacancy rates with regard to their historical experience albeit showing high unemployment rates. The matching process lies at the core of the issue of high unemployment.

⁴⁷ Further dimensions are cultural attitudes. Companies seeking higher profits at the cost of employing more workers, i.e. (see Korpi, 2002 or Lapp and Lehment 1997).

⁴⁸ Larsen (2006) states that an economic recession in one region [...] imposes mobility for workers in this region, but it will reduce mobility in the other region. The effects on overall mobility are uncertain. Empirical results of mobility may depend on the size of the region under study and on border effects.

⁴⁹ An extreme example for regional differences in unemployment is Western and Eastern Germany. However, even in the Eastern German states regional differences are pronounced (see Blien, 2003). Elhorst (2000) provides an excellent overview of theoretical as well as empirical explanations for persistent regional unemployment differentials within Europe.

⁵⁰ Even if none of the mentioned factors drives the mismatch, mismatch can still occur as a result of the less intensive searching behaviour of the unemployed.

The utilized NAIRU model provided important insights into the mechanisms that determine the level and persistence of unemployment. Spahn (1999, 12) notes: “An increase of effective demand has to be the first step; this may have to be accompanied by wage moderation in case of heterogeneous labour. On the other hand, only lowering wages and enhancing labour market flexibility will revalue the currency, increase efficiency, but not employment.” We discussed in depth the aspect of wage, flexibility (institutions) and the heterogeneous worker (mismatch). How to facilitate the “effective demand” and the role innovation and technological progress plays for that and for unemployment, are yet, however, unsettled. In the next section, we look at the basic theories of innovation. Having a theoretical understanding of the phenomena of unemployment and innovation we will examine their interaction in the section thereafter.

2.2. Basic theories of innovation and technological progress

“Technological progress is an important component of growth and contributes to the endless restructuring of production units” (Cahuc & Zylberberg, 2004, 564).

“Throughout the world, *innovation* and globalisation are the two major sources of economic performance. They directly affect productivity, *job creation* and citizens’ wellbeing, and they help make it possible to address global challenges such as health and the environment. As their role has taken on greater prominence, their characteristics have evolved and policies have had to adapt” (OECD 2007, 9).

These statements demonstrate that the innovation phenomenon is not only relevant for studies about economic growth (see Guimares & Langley, 1994) but also for labour market studies.

In order to address the relationship between innovation and the labour market, we first have a look at what exactly is understood by innovation and technological progress. The second paragraph explains why innovation is particularly important for modern economies. Knowing about the importance of innovation we want to address the issue of how to measure the complex phenomenon of innovation.

2.2.1. Defining innovation and technological progress

Hall (1986) describes innovation as the activities of developing and commercialising new products and processes. Stoneman (2001, 4) defines technological change as "... changes in the goods and services produced and the means by which they are produced. Technological advances are changes where the new in some sense is considered superior to the old."⁵¹

These innovation activities and technological advances can generally be of two different types according to Freeman (1986). Firstly, they can be fundamental in nature. A fundamental innovation is characterized by the creation and utilization of a piece of novel scientific, technological or organizational knowledge. The second type of innovation is less "dramatic" in its nature and is called "incremental". Opposed to a fundamental innovation, an incremental innovation is based on the application of existing knowledge. These two **types of innovation** have two major areas of application, namely products and processes. While product innovations deal with the question *what* is produced, process innovations are targeted at *how* products are produced. Innovation is present in all sectors of the economy. In the industrial sector of the economy, we find technological products and process innovations in the appearance of goods as material outcomes. In contrast, in the service sector organisational process innovations and product innovations lead to intangible outcomes. Edquist & Res (2000) argue that intangible innovations in the service sector are not to be considered less important than innovations yielding material outcomes, which could be assumed.

2.2.2. The role of innovation in the economy

The restructuring of production in the context of technological progress -see the quote from Cahuc and Zylberberg in paragraph 2.2- impacts on different levels of the economy.

⁵¹ Technological progress, technical progress and innovation are often used as synonyms even though innovation constitutes only a part of technical or technological progress. We will also use them as synonyms. A comprehensive discussion of the terminology provides Holwegler (2003) and Mayer-Krahmer (1999).

On the **firm level**, restructuring the production units includes invention, innovation and diffusion.⁵² Invention defines the generation of ideas, or expressed differently: prototypes that are *technically* realisable. Innovation in contrast is the application of invention, or prototypes that are *economically* realisable. Given the case, an idea is invented and the production of a prototype is economically feasible, then what lacks for economic success is diffusion. Diffusion describes the use and spreading of a new product or process in the market. Firms can roll out technological and non-technological innovations (Schmidt & Rammer 2007).⁵³

On the **macroeconomic level** technological change comprise various facets. Among the important ones, we find the notion of creative destruction popularized by Schumpeter. He used the term to describe the process of transformation that accompanies radical innovation.⁵⁴ According to Schumpeter (1942), the most feasible unit to facilitate this radical innovation is the entrepreneur. The entrepreneur who enters the market with an innovative product or service thus is the guarantor for economic growth.⁵⁵ Another well-established concept is called the national system of innovation. One of the first comprehensive works is List (1841). In the time of the upcoming nation states, he discussed the list of ingredients necessary to establish a successful national system of innovation. The ingredients comprise the actors, the production technology with a focus on human expertise (see Nelson & Nelson 2002) and the functioning of knowledge generation, the learning process, diffusion,

⁵² The sequence of invention, innovation and diffusion is called the linear model of technological change (see Silverberg, 1990). The idea of this sequential model dates back to Schumpeter (see Ray, 1974 or Kromphardt & Teschner, 1986). Recent approaches include aspects of networks of innovation, outline a back, and forth model (see Pyka, 1999).

⁵³ Organisational and marketing innovations constitute non-technological innovation (see the Oslo Manual OECD (2005a) for details. Schmidt & Rammer (2007) find a strong relationship between technological and non-technological innovation, however not a one-to-one relationship. They state on page 32: "[...] technological innovators that combine their product and process innovations with both marketing and organisational innovations perform better in terms of sales with market novelties and cost reductions as a result of process innovations than those focusing only on technological innovations.

⁵⁴ Radical innovation is a synonym for fundamental innovation. Freeman (1986) defines a fundamental innovation as characterised by the creation and utilisation of a piece of novel scientific, technological or organisational knowledge. An incremental innovation applies existing knowledge only.

⁵⁵ Creative destruction indicates that economic growth does not follow a smooth process but is characterised by cycles. In the short-run, cycles adjust from season to season, from three to five years. or in the intermediate run from seven to eleven years. In the long run cycles may last as long as 50 years (see Kondratieff, 1926).

application and utilisation.⁵⁶ Malerba (2002) provides an analysis on the sectoral system of innovation and production. He extends the traditional sectoral approach by providing a conceptual and methodological framework that incorporates interactions among various players. Additional key factors are institutions and the global processes of knowledge and learning. His approach is adequate for understanding the underlying interaction that constitutes sectoral systems of innovation and production. A further popular approach is the new growth theory.⁵⁷ In the model of Romer (1990) technological change is the consequence of investment into R&D⁵⁸ that is facilitated by R&D (R&D) staff. He assumes instantaneous diffusion once new technology has been developed. Barro & Sala-i-Martin (1997) consider diffusion.⁵⁹ Nelson & Nelson (2002, 271) mention that technical diffusion has to be mingled with social technologies: "In the case of the rise of the industrial R&D laboratory, new social technologies are needed to support activities that create new physical technologies."

Besides methodological changes, the **focus of innovation** also shifted within the last 150 years. Economists at the time of List examined innovation on the search of the most powerful national system of innovation. More recently, innovation is seen as a source of job creation and a weapon to fight unemployment (see Freeman, 1995) also in smaller geographic units: regions and cities. As a country economically develops, its sectoral focus changes from production of low technological goods – like wood products or textiles and paper - to technologically advanced goods and services with significant innovative activity like pharmaceuticals or ICT⁶⁰ products and services. Countries transform from developing to highly developed economies. Highly developed countries show lower growth rates with respect to their level of gross domestic product. They score comparatively high in per capita income and show high levels of capital stock and R&D activities. Large R&D activity allows

⁵⁶ For a historic perspective of the national systems of innovation see Freeman (1988). For other concepts of innovation systems on various levels see Lundvall (1988), Carlson (1995) or Edquist (1997).

⁵⁷ For a compact overview of old and new growth theory refer to Solow (2000).

⁵⁸ In the Frascati Manual (2002, 30) R&D is defined as: "Research and experimental development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications."

⁵⁹ Diffusion is particularly important in a globalised world. The mega trend of globalisation reduces barriers of technological diffusion, enhances international cooperation in R&D, makes the newly created knowledge more easily available, intensifies competition and reduces innovation and product life cycles, makes the technological knowledge explode and accelerates technological diffusion (see Gassmann & Bader 2006).

⁶⁰ ICT= Information and Communication Technology

for development of more innovative products and services.⁶¹ The tool to make R&D expenditure usable is man's intellectual power. Lucas (1993) argues: "The main engine of growth is the accumulation of human capital - of knowledge- and the main source of differences in living standards among nations are differences in human capital." Funk & Plünnecke (2005) confirm the importance of human capital. They refer to several studies and extract crucial conditions for current growth performance of an economy. They find that top graduates are more important as human resources the closer an economy gets to the technological frontier. Furthermore, they point at the importance of financing possibilities and the general framework of product and labour market. Within the general framework, patents, market size, age structure of the population and the quality of the education system play a role. According to Krumm & Strotmann (2004) a country - being a technological and economic leader – has to develop new products and procedures continuously in order to hold its prosperity level and level of employment. Acemoglu *et al.* (2002) state for such a leader, radical opposed to incremental innovation determines economic growth. This also holds for Germany.

Public financing of R&D demonstrates its **crucial role for modern societies**. Navarro (2006, 3) states, "there is a role for the public sector to organise publicly funded R&D or to enhance the incentives of private firms to invest in knowledge creation." Besides the role of the public body, private investments in R&D are becoming increasingly important.

2.2.3. Measuring innovation

As a starting point for capturing and measuring technological progress,⁶² we refer to the knowledge production function of Griliches (1979) that knowledge is at the core of the innovation process. In the function of Griliches (1979) K_t , the current level of technological progress, depends on $W(B)R_t$, an index of current and past levels of R&D expenditure and v_t , a set of unmeasured influences on the accumulated level of knowledge. Note that $W(B)$ is a lag polynomial, describing the relative contribution of past and current R&D levels to K_t , and B is the lag (backward shift) operator⁶³, G represents function of. Thus, the current level of technological progress can be represented by $K_t = G[W(B)R_t, v_t]$. The approach of Griliches is that

⁶¹ RWI (2005) shows the more economically advanced a country, the higher its need for R&D.

⁶² For a comprehensive guide in measuring and interpreting innovation data refer to the Oslo manual of the OECD (2005a).

⁶³ $W(B)R_t = (w_0 + w_1B + w_2B^2 + \dots) R_t = w_0R_t + w_1R_{t-1} + w_2R_{t-2} + \dots$

incumbent firms engage in the pursuit of new economic and technical knowledge as an input into the process of generating innovative activity. New economic and technical knowledge is made possible by R&D expenditure (see also Cohen & Klepper, 1991, 1992). Romer (1990) in his previously cited model adds to the expenditure of R&D from Griliches a second ingredient of technological progress: Human capital, labelled R&D staff. Based on these works, Audretsch (2005) provides a simple version of a **knowledge production function** that links innovative inputs to output.⁶⁴

$$I_i = \alpha RD_i^\beta HK_i^\gamma \varepsilon_i \quad \text{with } \beta < 1; \text{ and } \gamma < 1 \quad (1.7)$$

where I stands for the degree of innovative activity⁶⁵, RD represents R&D inputs⁶⁶, HK represents human capital inputs, i is the unit of observation, ε is a factor comprising influences not captured by RD and HK , and finally β and γ are indices for the impact of RD and HK . It has to be noted that the explanatory power of the equation is particularly strong at aggregated levels, such as industrial sectors or regions (see Griliches, 1984) and thus, fits well as underlying theory of our macro economic model.

The Eurostat Yearbook (Eurostat 2005, 209) confirms the **importance of R&D** for the innovation phenomenon⁶⁷: “R&D is a driving force behind economic growth, job creation, innovation of new products and increasing quality of products in general, as well as improvements in healthcare and environmental protection.”

The relevance of human capital in the innovation process can be observed by the following quotes: “Nothing will matter more to Europe’s future than the ability of countries, governments, workers and companies to innovate – a process which will depend in no small degree on the efficiency of our decision-making and the quality of our human capital” (see Ederer 2006, 2).

⁶⁴ The function represents a short-cut approach to the complex phenomenon of innovation. OECD (2005, 22) states: “First, R&D is an input. Although it is obviously related to technical change, it does not measure it. Second, R&D does not encompass all the efforts of firms and governments in this area, as there are other sources of technical change, such as learning by doing, which are not covered by this narrow definition. The same restricted view applies to human capital. See UN (2005) for measurement and handling of R&D data.

⁶⁵ The statement of Griliches (1990, 1701) still holds: “In spite of all the difficulties, patent statistics remain a unique resource for the analysis of the process of technical change. Nothing else even comes close in the quantity of available data, accessibility, and the potential industrial, organizational and technological detail.”

⁶⁶ As an example of how to collect and measure R&D data see the Frascati Manual (2002) of the OECD.

⁶⁷ MERIT and the Joint Research Centre of the EC in the European Innovation Scoreboard (EIS 2007) calculate a summary innovation index comprising 26 different indicators for the 27 EU member states. The indicators are assigned to five dimensions and grouped into firstly, drivers contributing to innovation input and secondly, others that measure innovation output.

“... the innovativeness of regions is significantly associated with their economic performance [measured as log GDP per capita] and by the presence of high-skill workers [measured by log % of workers with high-level education]” Taylor (2005, 150).

Empirically, the relationship between **R&D expenditure** and innovation intensity- on an aggregate level- can be observed by the following figure:

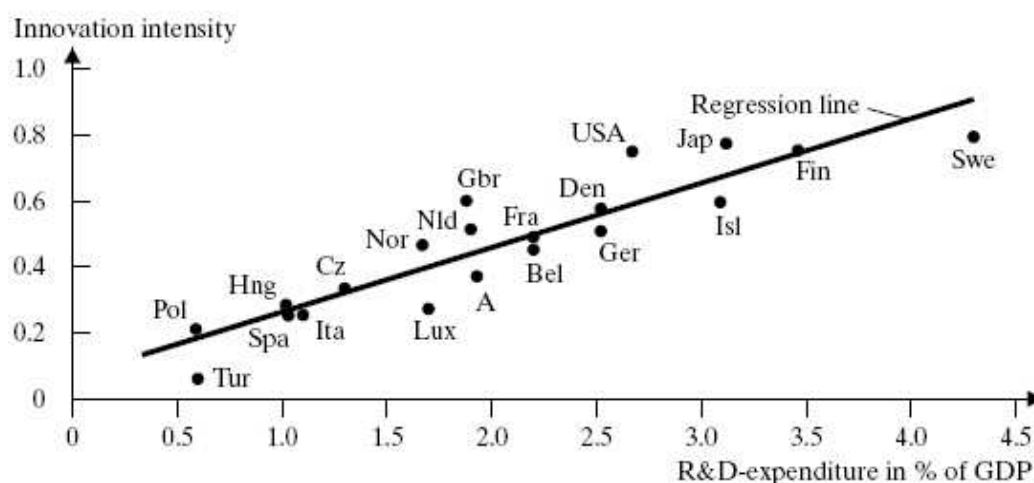


Figure 2-2: Research and Innovation Intensity (source: RWI 2005, 8)⁶⁸

The appropriateness of R&D expenditure as a measure for innovation is widespread. A close relationship between innovation inputs - like R&D expenditure - and innovation output – like the number of patents/GDP as proposed by Paci & Pigliaru (2001) exists. They find this relationship to be 0.91 for European Regions in 1990. Innovation in services and industry differs. Evangelista *et al.* (1997) found that diffusion processes based on technology acquisition accounted for a much higher share of total innovation expenditures than R&D, which accounted for only 20% of total expenditures for innovation. In comparison, capital investment in new equipment accounted for 50%, trial production for 11%, production design for 10%, and other activities for 9%. Arundel & Hollanders (2006, 3) state: "Innovation as diffusion is probably even more important in the service sectors that account for between 60% and

⁶⁸ RWI (2005): "The innovation intensity is a standardized indicator between 0 and 1, which consists of 12 partial indicators, including, among others, indicators for human resources, patents and for R&D intensity. In this respect, a part of the very close correlation of both data rows (determination coefficient of 84%) is to be explained by the fact that the innovation intensity is also affected by R&D indicators.

73% of value-added in the EU." Kanerva *et al.* (2006, 3) examine whether innovation in the services sector can be measured and compared in different countries within the EU.⁶⁹ They find: "It is not so much that the two sectors [industry and services] innovate differently, although they do, but that the nature of service sector innovation could rely much less on the accumulation of capabilities, permitting service sector firms to move much more rapidly to best practice than manufacturing firms." This becomes apparent when comparing key measures of innovative output for industry, patents, with that of services, trademarks. Kanerva *et al.* (2006, 3) explain: "[...] the ability of a service sector firm to introduce a trademark does not require cumulative scientific and technical knowledge and could be out-sourced if necessary. Furthermore, it might be much easier for firms to introduce organizational innovations through imitating best practice than it is for manufacturing firms to introduce a new invention, since key inventions are often patented and require the ability to 'invent around'."

The importance of **patents** for the innovation process for industry opposed to services can be seen in the development of patent application in the last years. According to IWD (2006a, 8) 145.241 patents have been registered at the EPO (European Patent Office) in 2000, whereas in 2004 already 178.579 have been registered. Software patents increased by 60% compared to an overall increase in patent registration of 23%. However, the relative importance of patenting in industry opposed to the services sector can be derived from the fact that most patents- even software patents - are issued by industry and only a small fraction by software companies. This can be easily explained by the fact that software as such cannot be registered as a patent. An exception to the rule is, when the software solves a technical problem. The advantage of big companies issuing patents rather for strategic instead of usability reasons can be imagined when looking at the cost of 30.000 Euros when registering a patent at EPO.

To conclude, the most important measures of innovation are R&D expenditure as a percentage of GDP- especially for industry- and a human capital measure - like the percentage of workers with high-level education from a theoretical and empirical point of view.

⁶⁹ Kanerva *et al.* (2006, 4) state: "[...] we can partly measure service sector innovation [however] there are serious difficulties in comparing service sector innovation *across countries*. We may need to focus analysis to intra-national comparisons, for instance by comparing performance among different service sectors within each country. Alternatively, comparisons of service sector innovation between countries might need to be limited to *countries at similar levels of development* in terms of GDP per capita or technical innovation capabilities."

2.3. Innovation and the labour market

“Those who agitate against new machines, do not consider that once the plough, the flour mill, the wheel, the saw, the axe, and even the spade have been new invented machines” List (1834).⁷⁰

“We are being afflicted with a new disease of which some readers may not yet have heard the name, but of which they will hear a great deal in the years to come – namely technological unemployment...” Keynes (1931).

Technological progress is curse and blessing. It improves our living standards but it is also made responsible for job-losses of thousands of workers.⁷¹

First, note that there is no such thing as *the* technological progress. Economists provided manifold concepts to capture the facets of technological progress or innovation (see Stoneman, 1983 or Archibugi *et al.*, 1994). For its impact on employment, see the following graph.

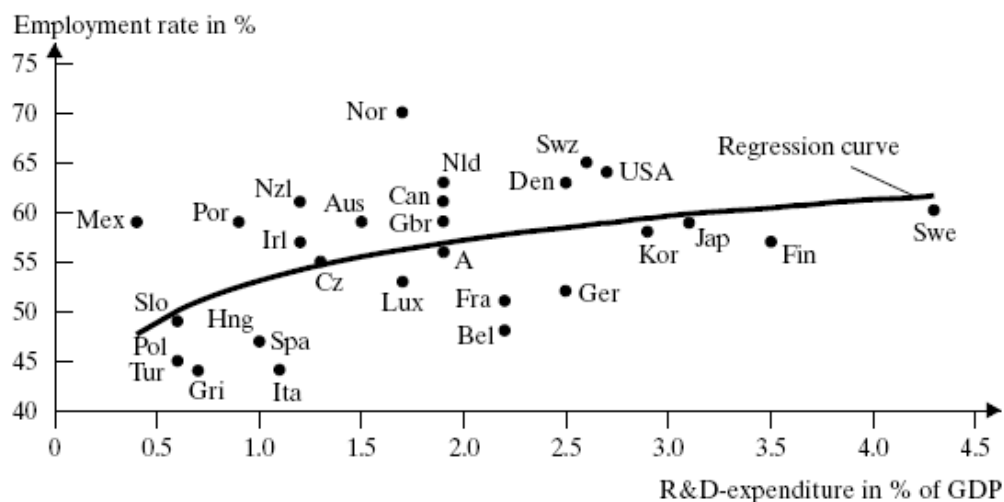


Figure 2-3: Research Intensity and Employment Rate (Source: RWI 2005, 12)

The graph shows a positive relation between R&D expenditure - measure of innovation and the employment rate - measure of employment, at least in tendency.⁷²

⁷⁰ Cited from Treue *et al.* (1966, 189)

⁷¹ For a detailed discussion about job-creation and destruction as a consequence of modern technologies for Germany see Meyer-Krahmer (1999).

⁷² We provide the same graph for the three Länder and Germany (West) in chapter 2.2.4. RWI (2005) defines the employment rate as labour force/population. We refer to this ratio as participation rate, whereas our employment rate stands for total employment/labour force.

Even though the relationship on a national level is not very strong, R&D expenditure affects innovation and employment and hence, innovation and employment are related through R&D expenditure. The weak relationship stems from innovation (through R&D) only being an additional factor in explaining employment and unemployment of countries or regions.⁷³ The weak relation calls for examining the main factors that lead to higher employment.

At first, innovation leads to the discharge of labour (Kalmbach, 1991). Whether the discharged worker⁷⁴ is able to find a new job plays the central role in answering the question whether innovation leads to higher employment or unemployment (Kähler, 1933).⁷⁵ In economic terms, the question is whether the mechanism of compensation or welfare effect (see Katsoulacos, 1984, 1986) prevails.

We discuss the following issues:

- First, *does product and process innovation lead to a different impact on employment?*
- Second, *does the increased buying power as a result of innovation, lead to a re-employment of the discharged workers?*
- Third, *does more export due to increased international competitiveness as a result of innovation cause re-employment of discharged workers?*

2.3.1. Product and process innovation and their impact on employment

Let us start with the classical definition of product and process innovation by Schumpeter (1934, 100): “1. The introduction of a new good —that is one with which consumers are not yet familiar—or of a new quality of a good. 2. The introduction of a new method of production, which needs by no means be founded upon a discovery scientifically new, and can also exist in a new way of handling a commodity commercially...”

⁷³ Other factors such as the demographic development, immigration, labour market rigidities, changes of the labour force structure, labour market-policy measures and statistical recording problems affect the employment rate. Furthermore, as described in the paragraph 2.2.3 R&D expenditure is not a composite indicator for innovation.

⁷⁴ For the following discussion we assume a simplified macroeconomic setting in which a worker is a worker; so there are no differences in educational level, geographic mobility or personal preferences.

⁷⁵ For the impact of innovation on productivity see the concept of the employment threshold. In this context Okun’s law (see Hagemann & Seiter, 1999a) and the Verdoorn approach (see Hagemann & Seiter, 1999b) provide important insights (for a discussion see Erber *et al.* 1998).

For this paragraph, we base our understanding of innovation upon Schumpeter's definitions.⁷⁶ Product innovation – and especially an additive product innovation – leads to the mechanism of compensation. The reasoning follows this route: the new good creates new consumer demand. In order to satisfy the new consumer demand more workers are needed to produce the new goods that increases employment.⁷⁷ Most economists assign positive employment effects to product innovations (see Hagemann, 1985 or Katsoulacos 1986, or Lederer 1938 in: Hagemann 2000). Also in the case that new goods substitute existing goods, positive employment effects can prevail. Impacts on employment also depend on which firms introduce the new goods.⁷⁸ Best for employment is if new firms introduce new goods. New firms have a lower market power and in tendency increase the consumer surplus by lower prices.

The situation for process innovations is less promising. Process innovation increases efficiency so that less input leads to the same output or the same input leads to increased output.⁷⁹ The efficiency gain has the potential to alter the relative factor productivity of capital and labour. A change in the relative factor productivity can cause a change in the relative shares of the factors of production. In the case the efficiency gain is attributed to capital, labour could be unchanged whereas if the efficiency gain is labour specific, fewer workers might be needed to produce the same amount of products.⁸⁰ Consequently, workers might be laid off.⁸¹ When considering a good's demand, the impact on employment depends on the price

⁷⁶The distinction between product and process innovation is not obvious (see Edquist *et al.*, 1997) and does not fully capture the increasing relevance of services in developed economies (see OECD, 2005). For studies on innovation in services and its contribution to economic growth see de Jong *et al.*, 2003; Hauknes, 1998; Howells and Tether, 2004; also Miles, 2005).

⁷⁷ Often consumers are also willing to pay higher prices for new goods so that also the wage for workers might be increased while still increasing employment. Especially big companies can introduce new goods at higher prices when exhibiting their market power.

⁷⁸ Holwegler (2003) argues that the time and the range of diffusion also play a decisive role whether innovation results in positive or negative effects of employment. A process innovation with a substitution effect decreases employment. The range of diffusion matters especially in the case of general purpose technologies (see Helpman, 1998)

⁷⁹ As an example consider the approach of lean management (see Fauser, 2007 for how lean production philosophy can increase productivity in the services sector).

⁸⁰ Note that if a change in total factor productivity is not attributable to a change in capital or labour productivity the outcome on unemployment is uncertain. The historic rise in US unemployment in the 1970s and 1980s and the downward movement in the 1990s might be a result of a decrease in TFP in the 1970s and 1980s and an increase in TFP in the 1990s. However, it might well be a result of several unrelated developments. On the role of productivity see Ball & Moffitt (2001).

⁸¹ When considering the process of job creation and job destruction, we get a different result. Cahuc & Zylberberg (2004, 572) state: "...stronger productivity growth increases the exit rate from unemployment", and on page 625: "Growth in labour productivity improves the profit outlook. This capitalization effect is favourable to employment."

setting of the company. If the price of a good is reduced because of gains in efficiency, the good's demand should increase. The higher demand could then lead to -*ceteris paribus*- higher demand for workers. Hence, the effect of a process innovation on employment depends on the price elasticity of demand (see Blien, 2005 for the case that capital and labour shares remain unchanged). Besides the price elasticity of demand, also the development state of a technology affects employment development: "As a general rule technological progress does not apply to all jobs in a uniform manner. Jobs based on obsolete technologies are destroyed, and only those capable of integrating the latest innovations survive. This process of creative destruction can be unfavourable to employment" Cahuc & Zylberberg (2004, 625). The following quote summarizes the majority of studies on the influence of product and process innovations on employment. Vivarelli *et al.* (1996) state: "The overall negative impact of technology on employment ... is found to be caused by the dominant role of process innovations and embodied technical change in firms' innovative activities. An opposite labour-increasing pattern can be found in some sectors characterised by ... higher percentages of product innovations."

2.3.2. Innovation driven increase in buying power and consequences for employment

Say (1819) stated that a *general glut* is impossible to exist. In an economy as a whole, he argued, demand and supply will always match - at least in the long run. Given perfect competition and short-term disequilibrium arising then a self-regulating mechanism, leads in tendency to equilibrium of all production factors with full employment (see Mettelsiefen, 1981). In order to illustrate the mechanism – in a simplified manner - assume that innovation enables a firm to produce the same amount of goods with fewer workers. Therefore, the price for the produced goods declines as the firm has to adjust its price level due to perfect competition. The decreasing price for the product enables consumers to buy more of the product. Higher demand causes firms to produce more products for which they need more workers. In the world of perfect competition and in the long run the discharged worker will be re-employed.⁸²

⁸² For an in-depth discussion see Patkin (1965), Lange (1942) and for the central assumptions to be made in order to make it true see Blaug (1985).

2.3.3. Innovation driven increase in exports and consequences for employment

Dealing with the question of innovation in an open economy takes the existing argument to another dimension. Referring to the dimensions of innovation diffusion from Stoneman (1983, 67), we now focus on the fourth dimension. In the preceding sections, we dealt with intra-firm diffusion, inter-firm and intra-industry diffusion, less with inter-industry diffusion, whereas now, we consider international diffusion.⁸³ The arguments and mechanisms themselves are mingled with the trend of globalisation.⁸⁴ Ricardo (1821, 396) notes: “By investing part of a capital in improved machinery, there will be a diminution in the progressive demand for labour; by exporting it to another country, the demand will be wholly annihilated.” The quote of Ricardo implies the compensation argument widely discussed for a region specializing in machinery. The region that produces competitive machines and sells those machines might be able to compensate for the detrimental effect the machines themselves have on employment in the region at first. Even if the demand for machines leads to an increase in demand for workers producing those machines, the reallocation process of workers being fired and re-employed implies friction (see Klauder, 1986) and a mismatch of a worker’s qualification can arise. If the region for the uncertainty of its effects on employment does not innovate and participates in international trade, it reduces its international competitiveness. Therefore, more goods are imported, fewer goods are produced domestically, demand for workers decreases and unemployment increases. The two most important determinants that constitute international competitiveness are price and quality.⁸⁵ Countries that offer products of a higher quality are able to increase exports as well as such countries that are able to offer

⁸³ The more aggregated the unit of observation in studies on technological progress from the industry, to the national economy until the global economy, the higher the risk of not considering the gradual diffusion of innovation in a firm or household. As a way out, Holwegler (2000) points at the vintage approach which also considers at a macro economic level the fraction of new capital stock-representing the new technology – to total capital stock. Salter (1960) exploited the vintage approaches for the diffusion theory.

⁸⁴ Gerybadze (2004) describes the mega-trend of globalisation with explosion of technical knowledge, technology-integration of scientific areas, decentralisation of knowledge, intensified competition, shorter cycles of innovation, increasing diffusion of innovation.

⁸⁵ Products with a higher quality yield higher prices on the world market, Schott (2008). In the case of US imports, machinery imported from China (a low-wage country) compared to machinery imported from Japan (a high-wage country) exists a 60% price discount of the Chinese products. He argues that the consumer is willing to pay such a higher price for the Japanese products as these products are of higher quality.

cheaper products. In the case of high-wage countries, higher exports can only be achieved by assembling products of a higher quality. Increasing exports should then increase the demand of goods and finally lead to re-employment of workers. A problem with this argument is that increasing exports implies increasing technological trade. The more technologically advanced goods are exported the more technological knowledge imminent in these goods is exported. This knowledge can be used by the country of destination to produce similar goods and hence, the competitive advantage erodes. If the high-wage country did not produce a qualitatively superior product by the time, the technological advantage eroded, exports will diminish and workers will be discharged. Besides the described compensation argument, re-employment of workers depends on factors such as terms of trade, income elasticity and technological competitiveness (OECD, 1994 and Schumacher *et al.*, 2003).

The chapter has shown that labour market theory and innovation theory are two pivotal and complex topics. We know about the importance of innovation theory in designing a labour market model, as both phenomena are interrelated. Both phenomena are determined by manifold factors and mechanisms. The difficulty consists in choosing a manageable number of key-factors for adequately estimating the unemployment rate. We shall introduce main economic variables of the unit under study in Chapter 3. Chapter 4 provides a description of data that enables us to construct an econometric model and estimate key relationships in Chapter 5.

3. The diverse Economic Structure of German Federal States

Chapter 3 provides basic economic facts of our units of analysis. After a brief look at the structure and main economic facts of Germany, we present economic key variables of three characteristic German states and the Western German average. We decompose the widely used measure of wealth - GDP/head - into its elements. The elements equal some of the core variables in the labour market model in Chapter 4. The approach also allows skipping the presentation of standard measures for the variables in the data chapter as we already have an impression about how the data is shaped. In detail, we look at measures of wealth, growth, employment as well as unemployment and innovation. We examine whether we find evidence for convergence or divergence in these measures. At the end of the chapter, we will have a clear picture of the economic set up and the relevance of core variables for the states' competitiveness. The characteristics of the states provide the background for interpreting the estimates of the labour market model in Chapter 5.

3.1. Key figures of the German economy and reasons for focussing on West Germany

Total population of the Federal Republic of Germany is about 82 mio in 2008 (Statistisches Bundesamt 2008a). Total GDP in 2007 amounted to 2423 B Euro (Statistisches Bundesamt 2008b, 5) which corresponded to 29.600 EUR/head and to 27% of total nominal Eurozone GDP. The agricultural sector amounted to 0.9% of total GDP, the industry sector to 30% and the services sector to 69.1 %. In 2007, Germany's exports amounted to 969 B EUR, its imports to 772.5 B EUR. Net exports were highest ever with 196.5 B EUR (Statistisches Bundesamt 2008c). In 2007, Germany occupied the first rank in world exports. The Federal Republic of Germany constitutes of 16 states- the Laender⁸⁶. Since 1990 the former Eastern German Laender (Mecklenburg-Western Pomerania, East Berlin, Brandenburg, Saxony-Anhalt, Saxony, Thuringia) joined the 11 Western German Laender

⁸⁶ We utilize the expression "Laender" instead of federal states or regions for the sake of simplicity and clarity. A region can take the form of Europe or of a small district, for example.

(Schleswig-Holstein, West Berlin, Hamburg, Lower Saxony, Bremen, North Rhine-Westphalia, Hesse, Rhineland-Palatinate, Saarland, Baden-Württemberg, Bavaria).



Figure 3-1: Federal German states, the Laender (source: Bundesrat 2008)

Besides its economic strength, Germany also faces considerable challenges. Heckman (2001, 357) states: “The German economy lacks the robustness and vitality it possessed in the Erhard era. It is still a strong economy, competitive in medium-high technology trade, but it could be stronger. Unemployment is high, employment growth is low, and its competitive position in world trade is weak in areas of high technology, such as computers, communication technology, and biotechnology.” He names two causes why Germany does not exhibit all its economic strength: **weak incentives to invest in skill (human capital)** and the **inability** of the German system **to respond to change rapidly**.

Looking for the structure at the sub-national level, we observe economic and scientific indicators of three typical West-German Laender. We focus on West-German Laender as even 20 years after “German unification”, we still observe huge differences between Eastern and Western Laender. Furthermore, data availability for Eastern German Laender before 1990 is limited. In the next section, we also provide the Western German mean as comparison.

3.2. Three characteristic West-German Laender and their distinct economic development

The economic development and structure of Germany is far from homogenous. Differences between the Laender exist in population size, industry structure, as well as GDP per capita and GDP growth. For an easy to manage but specific analysis, it is best to choose a selection of Laender representing the characteristic regional economic structures of Western Germany.

3.2.1. Reasons for selecting Baden-Württemberg, North Rhine-Westphalia and Schleswig-Holstein

We select the Laender Baden-Württemberg (BW), North Rhine-Westphalia (NW) and Schleswig-Holstein (SH). The three Laender represent the three types of heterogeneous economic structures, observable in Western Germany. As a benchmark, observe the figures of Western Germany (DE).⁸⁷ The **diverse economic structure** coincides with the geographic location North, West and South. The following table provides figures on population and GDP.

Table 3-1: Population and GDP of BW, NW, SH, DE

Figures	Population in 2007 ^[1]		GDP in 2007 ^[2]		GDP growth ^[2]	
	total in mio.	% of DE	total in mio. EUR	% of DE	in 2007 in %	2000=100
BW	10.75	16.4	352.95	17.1	4.5	118.7
NW	18.01	27.4	529.41	25.7	4.7	116.5
SH	2.83	4.3	72.25	3.5	3.3	111.4
DE	65.65	100.0	2061.82	100.0	4.4	117.9

^[1] source: VGR DL: http://vgrdl.de/Arbeitskreis_VGR/tbls/tab20.asp (visited 19/8/08)

^[2] source: VGR DL: http://vgrdl.de/Arbeitskreis_VGR/tbls/tab01.asp#tab02 (visited 19/8/08)

BW represents an innovative, economically strong Land characterised by a high share of industry, high export rates⁸⁸ (42.7%) and low unemployment. BW specializes

⁸⁷ Comparing Laender situated in the West of Germany to the Western – opposed to the total - German average makes more sense.

⁸⁸ The export share as a fraction of total GDP is an important measure of the extent of trade globalisation. OECD (2005c, 177) notes: "In terms of level, this ratio [value of exports / value of

– employment above Western German average - in the three areas of computer, data processing as well as electrical engineering, optical industries, mechanical engineering as well as in vehicle construction (Jahn & Rau 2006, 8). It is situated in the South (borders to France and Switzerland) of Germany. NW represents a medium-innovative, about economically average performing state where services play an important role but industry also remains important. Its openness is medium (export rate: 32.9%), and it experiences an unemployment rate similar to the German mean. NW specialises in four major areas: metal production, metal processing as well as trade and mining and chemical industry (Amend & Bauer 2006, 27). NW is situated in the West (borders to the Netherlands and Belgium). SH represents a low innovative, economically weak state, mainly based on services and whose economy is not that open (export rate: 23.7%). It specialises in three main areas: area municipality (public employee) of social insurance as well as in trade and in health together with social services (Niebuhr & Kotte 2005, 36). Its unemployment rate is similar to NW's. It is situated in the North of Germany (border to Denmark).

Based on the regional as well as on the sectoral dimension, **specific strengths and weaknesses** can be detected of the three representative German Laender. Besides a general representation of the main macroeconomic facts, it shall be examined whether evidence for convergence or divergence in main economic variables between 1975 and 2005 can be found.⁸⁹ Searching for the relative

GDP] may indicate the intensity of a country's trade." Factors like the proximity of a country to its major trading partner and the countries' economic size influence the export share.

⁸⁹ The convergence theory stems from the neoclassical model of economic growth. Main contributors are Ramsey (1928), Solow (1956), Cass (1965), and Koopmans & Tjalling (1965). In the neoclassical model, the growth rate of capital per worker is negatively related to the initial level of this variable. This implies decreasing returns to scale of capital as countries grow. The consequence constitutes the fact that all economies grow towards a stable equilibrium. In the equilibrium, capital stock, workers, production and population all grow at the same rate. This results in a steady state with a zero growth rate per head. Given these properties, the model predicts all economies with similar characteristics - identical preferences and identical technologies - to converge towards the same steady state. In steady state, all the values of the countries variables are at the same level. This situation is called absolute convergence. In contrast, in case of non-identical characteristics- like differences in preferences and technology- , the level of the variables is different at the steady state for each country. In this case, all the countries converge towards their own steady state where the differences of the variables only reflect the differences of the initial level. According to Barro and Sala-i-Martin (1995) this situation is called conditional convergence. In the case of conditional convergence, the speed of convergence of each country towards its steady state is a decreasing function of the distance to its steady state level. Depending on the different individual steady states of the countries, conditional convergence can also imply divergence. Main criticism of the neoclassical model used for convergence analysis stems from the fact that it is a model of the closed economy, without international capital flows, without migration and does not consider the importance of human capital especially for technological progress. Instead of applying the exact function for a convergence analysis of Barro Sala-i-Martin

development of the Laender, we begin with the standard measure of wealth – income per head (GDP divided by the population). We decompose the **measure of wealth** into growth factors that determine the level of GDP per capita. In doing so, the basic causal relationship proposed by Voskamp & Schmidt-Ehmcke (2006, 8) emerges.

$$\frac{GDP}{POP} = \frac{GDP}{totHW} \times \frac{totHW}{TE} \times \frac{TE}{LF} \times \frac{LF}{POP} \quad (3.1)$$

The first factor of growth is GDP divided by total hours worked (GDP/totHW) or **labour productivity**. Labour productivity is considered the essential measure of growth emanating from innovation. The second factor of growth is **working hours per head** and year (total hours worked divided by total employment, totHW/TE) - which is the quantity of labour input, or a measure of labour hoarding. Another growth factor is **total employment divided by the labour force** (TE/LF), which measures the utilisation of potential labour. This measure can be considered as the complement to the unemployment rate. The fourth factor of potential growth is the ratio of **labour force to total population** (LF/POP). This is another quantity measure, widely known as the participation rate.

The next sections provide and discuss the corresponding regional figures of the indicators in the same order as in the equations. The measure of labour productivity, (GDP/totHW), is kept for the very end, however. We observe regional differences in income per capita and examine where the differences emanate from.

3.2.2. Income per capita in comparison

The following table⁹⁰ shows values for 1975, 1991 and 2005 and indicates whether evidence for convergence or divergence exists:

(1995) we only look at the values of our variables of the three Laender at three points in time at the beginning, in the middle and at the end of our data period. Comparing the ratios of the Laender's values at the points in time allows drawing a short-cut conclusion of convergence or divergence over time.

⁹⁰ Figures presented in the chapter are based on data in the data chapter. We utilize the same data in the model and estimation exercise, where not indicated otherwise.

Table 3-2: Basic economic indicators

Figures

	GDP/POP in EUR/head			GDP/totHW in EUR/h			totHW/TE h/head			TE/LF as fraction			LF/POP as fraction		
	1975	1991	2005	1975	1991	2005	1975	1991	2005	1975	1991	2005	1975	1991	2005
BW	9386	23430	30102	14.30	35.12	50.18	1435	1308	1191	0.974	0.968	0.928	0.469	0.533	0.542
NW	9245	21184	27074	15.01	34.54	48.58	1525	1330	1195	0.964	0.937	0.895	0.419	0.493	0.521
SH	8192	19304	23995	14.89	33.48	47.95	1429	1264	1157	0.954	0.929	0.895	0.403	0.484	0.483
DE	8879	22030	29029	12.36	31.26	44.97	1693	1447	1338	0.966	0.948	0.909	0.439	0.514	0.531

Ratios

	GDP/POP			GDP/totHW			totHW/TE			TE/LF			LF/POP		
	1975	1991	2005	1975	1991	2005	1975	1991	2005	1975	1991	2005	1975	1991	2005
BW to NW	1.015	1.106	1.112	0.953	1.017	1.033	0.941	0.983	0.997	1.010	1.033	1.037	1.119	1.081	1.040
BW to SH	1.146	1.214	1.255	0.960	1.049	1.047	1.004	1.035	1.029	1.021	1.042	1.037	1.164	1.101	1.122
NW to SH	1.129	1.097	1.128	1.008	1.032	1.013	1.067	1.052	1.033	1.010	1.009	1.000	1.040	1.019	1.079
BW to DE	1.057	1.064	1.037	1.157	1.123	1.116	0.848	0.904	0.890	1.008	1.021	1.021	1.067	1.037	1.021
NW to DE	1.041	0.962	0.933	1.215	1.105	1.080	0.901	0.919	0.893	0.998	0.989	0.985	0.954	0.959	0.981
SH to DE	0.923	0.876	0.827	1.205	1.071	1.066	0.844	0.874	0.865	0.988	0.980	0.985	0.917	0.942	0.910

bold: indicates divergence relative to previous point in time (1991 to 1975; 2005 to 1991)

source: own calculations based on data from RA (2007) & MIK (2008)

In income per capita (GDP/POP) BW leads the group of representative Laender from 1975 until 2005. Whereas the level of wealth was about the same as the one of NW in 1975, it increased by higher rates to about 11% higher per capita output in 2005.⁹¹ The per capita output of SH did not only start from the lowest level in 1975 but also showed permanently smaller rates of increase compared to BW until 2005. In 2005, the measure of wealth of BW is more than a quarter higher than SH's value. Besides the divergence between the Northern and Southern state convergence can be observed between NW and SH for the first part up the data period and divergence in the second part so that in 2005, the gap reaches its initial level of 1975.⁹² When comparing the Laender to the Western German average we find divergence in wealth until 1991, BW increasing its wealth relative and NW as well as SH falling behind. After 1991 until 2005, SH and NW drop further back relative to Western Germany and BW shows signs of convergence to the German mean.

Having found evidence of divergence in wealth most interesting to not is where the divergence in wealth emanates from. The labour productivity (GDP/working hour) shall be maintained until the end and start with the quantity measure of total hours worked.

⁹¹ Also Badinger & Tondl (2003) find only little convergence in income per capita in countries, if any.

⁹² Divergence in growth does not stem from industrial concentration. Against the prediction of Möller (2001) who expects the European integration process to facilitate a specialization in the region's product mix and an increase in regional diversity, we observe a decrease in concentration in industry and services – measured by the GINI coefficient- within Germany (Haas & Südekum 2005).

3.2.3. Differences in hours worked

Table 3-3: Total hours worked per employed

Figures	tot-HW/TE h/head			Ratios	tot-HW/TE		
	1975	1991	2005		1975	1991	2005
BW	1435	1308	1191	BW to NW	0.941	0.983	0.997
NW	1525	1330	1195	BW to SH	1.004	1.035	1.029
SH	1429	1264	1157	NW to SH	1.067	1.052	1.033
DE	1693	1447	1338	BW to DE	0.848	0.904	0.890
				NW to DE	0.901	0.919	0.893
				SH to DE	0.844	0.874	0.865

bold: indicates divergence relative to previous point in time (1991 to 1975; 2005 to 1991)

source: own calculations based on data from RA (2007) & MIK (2008)

The most evident fact in total hours worked constitutes the decline in all Laender from 1972 until 2005. BW converges towards NW over the entire period and towards SH after 1991. The gap between NW and SH reduces over the entire sample period. The difference in quantity of hours worked between all Laender is only marginal and converges at least after 1991. The Western average always exceeds the three regions under study. Between 1975 and 1991, all Laender show signs of convergence until they reach about 90% of the Western German value. From 1991 onwards, they slightly diverge away from Western Germany between 1% and 2%. The difference between the three Laender and the Western German mean originates from the different sectoral structure. In other Laender of Western Germany, more people are employed in services and especially in private services. In these sectors, people work more hours. Furthermore, public holidays differ between the Laender.

3.2.4. Differences in employment, unemployment and participation rate

The **employment rate** (TE/LF) is also a quantity measure showing the level of employment in a region relative to potential employment. With the highest value in 1975 BW also shows the highest value in 2005. Compared to NW it has experienced a more favourable development of employment leading to divergence. Instead of an increase or decrease in employment of the Laender to DE, a constant pattern emerges after 1991. BW's employment rate remains at about 2% above DE. SH and

NW both show employment 1.5% below the German average. Whereas NW shows a tendency to loose ground, SH seems to close the gap slightly to DE. The difference between the employment rates of BW and SH first increased until 1991 before, in the more recent period, they show a slight tendency of convergence.

Table 3-4: Employment rate

Figures	TE/LF as fraction			Ratios	TE/LF		
	1975	1991	2005		1975	1991	2005
BW	0.974	0.968	0.928	BW to NW	1.010	1.033	1.037
NW	0.964	0.937	0.895	BW to SH	1.021	1.042	1.037
SH	0.954	0.929	0.895	NW to SH	1.010	1.009	1.000
DE	0.966	0.948	0.909	BW to DE	1.008	1.021	1.021
				NW to DE	0.998	0.989	0.985
				SH to DE	0.988	0.980	0.985

bold: indicates divergence relative to previous point in time (1991 to 1975; 2005 to 1991)

source: own calculations based on data from RA (2007) & MIK (2008)

No convergence can be observed in unemployment rates. Monastiriotis (2006) finds that unemployment differences between regions of the same country are often large and more pronounced than between countries that can be observed by the following graph.

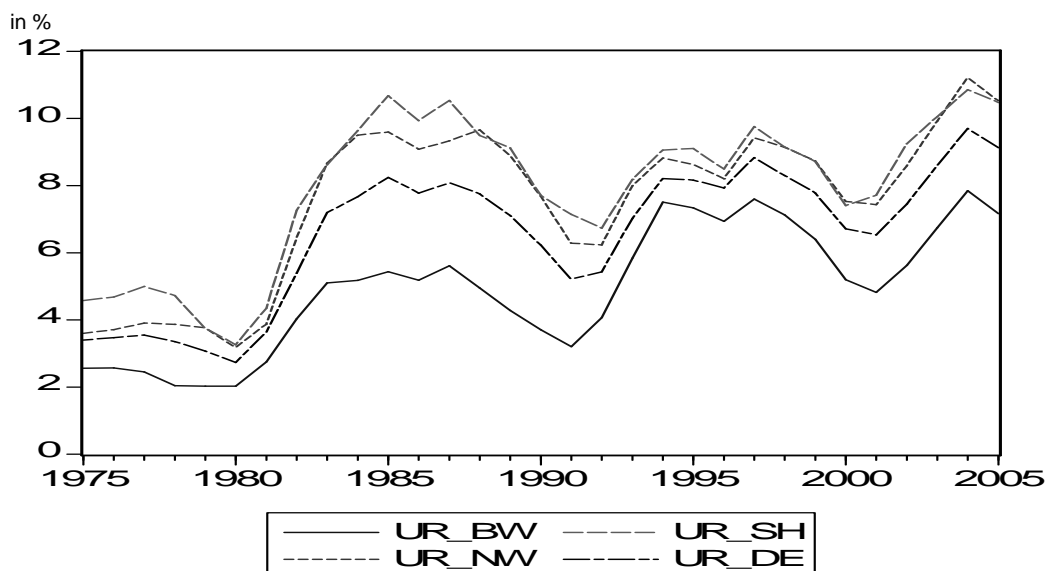


Figure 3-2: Unemployment rates of BW, NW, SH and DE from 1975 to 2005 (source: own; data from RA 2007)

In 1975, **unemployment** of all Laender and DE was lower. With increasing UR, the difference between BW and the other two Laender increased. Whereas SH already showed the highest unemployment rate in 1975, NW performed roughly like DE in 1975. After 1975, NW's trouble to evolve away from its traditional industrial structure of coal and steel becomes immanent. This reflects in a high unemployment rate. Obstfeld & Peri (1998) confirm the importance of the sectoral composition for employment. They state that 2/3 of the conditional variance of European sub-national unemployment rate can be explained by region-specific factors. Blien & Sanner (2006, 19) add: "Regions that exhibit a relatively large share of "young" industries, which produce goods that are at the beginning of their product cycle, [perform] far better in terms of employment than other regions. [...] Our theoretical analysis suggests that the rise and decline of employment is inherent in any industry, and thus inevitable." They argue that the unfavourable development of employment - due to process innovations- is worse if a region is less innovative than other regions (see the discussion in Chapter 2.3). The only way out of the dilemma is to specialise in products that are at the beginning of their economic life. Future development of a region decisively depends on its current sectoral structure. Blien (2005) notes that path dependence makes it hard for regions to develop away from its traditional structure. NW has lost its advantage relative to SH entirely from 1975 to 2005 so that employment and unemployment rates no longer differ.

Whether we observe convergence or divergence in regional unemployment rates depends also on the qualification of the workforce. Pressman & Klepfish (2008, 20) conclude in a study about regional unemployment convergence in Israel from 1970 until 2004: "Convergence of the unemployment rates among low-skilled is conditional, while convergence of the unemployment rates among high-skilled is unconditional."

Table 3-5: Participation rate

	Figures				Ratios		
	LF/POP as fraction				LF/POP		
	1975	1991	2005		1975	1991	2005
BW	0.469	0.533	0.542	BW to NW	1.119	1.081	1.040
NW	0.419	0.493	0.521	BW to SH	1.164	1.101	1.122
SH	0.403	0.484	0.483	NW to SH	1.040	1.019	1.079
DE	0.439	0.514	0.531	BW to DE	1.067	1.037	1.021
				NW to DE	0.954	0.959	0.981
				SH to DE	0.917	0.942	0.910

bold: indicates divergence relative to previous point in time (1991 to 1975; 2005 to 1991)

source: own calculations based on data from RA (2007) & MIK (2008)

Looking at the **participation rate** (LF/POP), the different starting points in 1975 are most obvious: PR was about 47% in BW, about 42% in NW and about 40% in SH. All three regions increased their rates until 1991. SH's rate increased by over 8% narrowing the gap to BW and NW. In the second part of the period, SW lost momentum so that the gap to BW and NW widened. NW converged to BW over the entire period by reducing the gap from about 12% in 1975 to about 4% in 2005. NW's participation rate advantage to SH first fell from about 4% in 1975 to only 2% in 1991, before NW increased its lead to 8% in 2005. BW's figures are about 2% ahead of DE's in employment and PR with the PR seeming to converge. Also NW's PR changed from 4% below DE's in 1991 to 2% below in 2005. In PR, SH first narrowed the gap to DE and then it widened again even below 1975's relative level.

Comparing the development so far, convergences of the Laender prevails after 1991 for hours worked per worker, slight divergence for the employment rate (0.4%), and convergence for the PR between BW and NW. Comparing BW to SH after 1991 shows divergence in PR (2.1%), whereas quantity of hours worked converges like the employment rate. Confronting NW to SH, one finds strong convergences in all indicators except for PR where NW increases the gap to SH (6%).

Comparing BW to SH the much higher PR could explain divergence in wealth. Comparing BW to NW, however, we find convergence in most factors and are puzzled by the question why BW's growth in wealth is so much higher than NW's.

In an attempt to solve the puzzle, we shall look at labour productivity.

3.2.5. Differences in labour productivity and innovation

Looking at the values of labour productivity (GDP/totHW) in 1975, BW's was about 5% lower than NW's. In 2005, BW's value was more than 3% higher than NW's. Hence, BW managed to be somehow more productive than NW and overtook NW in output per hour worked. Comparing BW to SH, in 1975, BW was about 4% less productive than SH, whereas in 1991 and also in 2005, BW was about

5% more productive than SH.⁹³ In the overall picture, all Laender are above but converge towards DE: SH and NW converge fast, BW converges much slower.

Table 3-6: Labour productivity (Output per hour worked)

Figures	GDP/totHW in EUR/h			Ratios	GDP/totHW		
	1975	1991	2005		1975	1991	2005
BW	14.30	35.12	50.18	BW to NW	0.953	1.017	1.033
NW	15.01	34.54	48.58	BW to SH	0.960	1.049	1.047
SH	14.89	33.48	47.95	NW to SH	1.008	1.032	1.013
DE	12.36	31.26	44.97	BW to DE	1.157	1.123	1.116
				NW to DE	1.215	1.105	1.080
				SH to DE	1.205	1.071	1.066

bold: indicates divergence relative to previous point in time (1991 to 1975; 2005 to 1991)

source: own calculations based on data from RA (2007) & MIK (2008)

The distinct speed of convergence might be explained by different competitive developments of the regions. According to Dornhauser (2005) gains in labour productivity relative to unit labour cost are a major measure for competitiveness. Dornhauser (2005, 24) writes: "From 1970 until 2004 labour productivity increased by 68% in Baden-Württemberg, and by 64% in Western Germany- without Berlin. [...]. With an increase in productivity of 41% North Rhine-Westphalia showed the lowest increase [of the Western German Laender in this period]. In the same period, unit labour cost in Baden-Württemberg rose by 155% and in Western Germany by 152%. In North Rhine-Westphalia we observed with an increase of 187% the strongest increase [of all Western German Laender] ..."

The highest increase in unit labour cost and lowest increase in productivity seems to have weakened the competitive position of NW relative to BW even though in 2004 BW had the highest labour cost in industry in Europe (Statistisches

⁹³ The sector-specific development of productivity explains the different development in labour productivity. The time paths of productivity in the industrial sector of the three states show a more or less identical development from 1975 until 1991. Then NW as well as SH showed a weaker productivity increase in industry than BW. While SH could not catch up significantly to BW, NW managed almost to converge to BW. The productivity figures of the service sector show a different picture. In spite of the positive overall trend, NW performed best from 1975 until about 1995. BW and SH both started at a lower position in 1975. Whereas BW managed to close the gap to NW until 1995, SH's service sector still ranked third. After 1995 BW overtook NW which, since then, has become the strongest Land also in service sector productivity.

Landesamt 2007).⁹⁴ Searching where the more favourable development in labour productivity in BW could originate from, refer to the phenomenon of **innovation or technical progress**. The fact that technological growth lies at the source of an increase in labour productivity confirms the two quotes at the beginning of Chapter 1.2. OECD and Cahuc & Zylberberg state that innovation is an important factor for productivity growth and growth in general. Specifically, factors considered relevant for the innovation process (input and output measures) for BW, NW and SH are important. If evidence emerges that the innovation process (for the selection of measures refer to paragraph 2.2.3) in BW shows a better performance than in NW and SH, this could explain higher labour productivity.

Table 3-7: Basic innovation indicators in BW, NW, SH and DE

Figures	RDexp/GDP ^[1]		RD staff/TE ^[2]		Ratios	RDexp/GDP		RD staff/TE	
	1991	2005	1991	2005		1991	2005	1991	2005
BW	0.0263	0.0340	0.0138	0.0152	BW to NW	1.948	3.090	2.007	3.060
NW	0.0135	0.0110	0.0069	0.0050	BW to SH	4.161	6.480	3.874	5.799
SH	0.0063	0.0052	0.0036	0.0026	NW to SH	2.136	2.097	1.930	1.895
DE	0.0180	0.0186	0.00925	0.00856	BW to DE	1.461	1.827	1.493	1.780
					NW to DE	0.750	0.591	0.744	0.582
					SH to DE	0.351	0.282	0.385	0.307

bold: indicates divergence relative to previous point in time (1991 to 2005; 1995 to 2005)

[1] RDexp/GDP: R&D expenditure in the economic (excl. public & other sectors) sector as a fraction of GDP; source: Grenzmann & Kladroba. (2007, p.53 & 54); Kreuels (2006, 103 & 104)

[2] RD staff/TE: R&D staff in the economic sector over total employment (dep. empl. & self-employed); source: Grenzmann & Kladroba (2007, p.53 & 54); Kreuels (2006, 103 & 104)

Looking at table 3-7, BW leads in 1991⁹⁵ and increases its effort in innovation intensity - consisting of capital inputs (business R&D expenditure⁹⁶) and human capital inputs (R&D staff⁹⁷/ TE) in absolute as well as in relative terms to NW and

⁹⁴ Wezel & Weinmann (2005, 41) provide a ranking of labour cost per piece of the German Laender: Baden-Württemberg second highest (+5.1% above German average), Schleswig-Holstein sixth highest (+0.4%), North Rhine-Westphalia seventh highest (-0.5% below German average).

⁹⁵ As already noted in the data section, innovation measures are only available since the beginning of the 1990s.

⁹⁶ OECD (2007, 30) proposes business R&D activity as the most appropriate measure of innovation effort of a country.

⁹⁷ OECD (2007, 54) defines and describes staff employed in R&D as follows: "R&D personnel includes all persons employed directly in R&D activities and therefore covers technicians and support

SH. In the case of business R&D expenditure to GDP the gap widens between BW and NW from roughly two to more than three percent of GDP between 1991 and 2005. Relative to SH, BW increases its R&D efforts from about 4 times as much in 1991 to about 6,5 times as much in 2005. In Comparing NW to SH less movement arises: NW remains spending about twice as much relative to its GDP in R&D and having about twice as much R&D staff relative to total employment than SW in 1991 and 2005. Comparing BW to NW and SH, the pattern for the R&D staff follows that of R&D expenditure. Following DE, note that BW increases its lead from about 50% more expenditure and R&D staff in 1991, to about 80% of both measures in 2005. NW and SH lose more ground on DE so that in 2005 their measures are only about 60 and 30 percent of DE's, respectively. Legler & Grenzmann (2006, 4) confirm our finding of higher R&D activities in BW: "That Munich, Stuttgart as well as Rhein-Main-Neckar [also in BW] are at the top [of R&D concentration] indicates a twofold innovation divide within Germany; a South-North divide on the one side within West-Germany and a East-West divide between West-Germany and East-Germany despite intensive governmental aid for East-Germany." Following these findings, we note an increase in the share of the R&D labour force that generates level effects rather than long-run growth effects. An increase in R&D staff and R&D expenditure only temporarily increases the growth rate until the economy reaches a higher level of income (Romer 1990). In addition, investments in R&D staff and R&D capital often show long time lags until they take effect. Their effect, neither reads one to one in the balance of growth of regions nor in the employment trend, says Legler (2006). Audretsch (2006) writes: "Findings suggest that the innovative output of all firms rises along with an increase in the amount of R&D inputs, both in private corporations as well as in university laboratories." With BW showing higher R&D input – RD staff and RD exp.- than BW and SH, we shall also expect higher output like value added in innovative industries and services.. Looking at the table below this seems to hold for industries, only.

staff in addition to researchers. R&D personnel can be expressed both in full-time equivalents (FTE) on R&D and in headcounts."

Table 3-8: Further basic innovation indicators in BW, NW, SH and DE

Figures	EINDH/EINDL ^[3]		ESERH/ESERL ^[4]		VAINDH/VAIND ^[5]		VASERH/VASER ^[6]	
	1995	2005	1995	2005	1995	2005	1995	2005
BW	0,7572	0,9233	0,6167	0,7354	0,4792	0,5482	0,5848	0,5882
NW	0,4434	0,4716	0,5792	0,7248	0,3393	0,3690	0,5576	0,5798
SH	0,4547	0,5006	0,5109	0,6112	0,3027	0,4042	0,5421	0,5744
DE	0,55938	0,65353	0,58607	0,71481	0,39691	0,45832	0,56945	0,5980

Ratios	EINDH/EINDL in %		ESERH/ESERL in %		VAINDH/VAIND in %		VASERH/VASER in %	
	1995	2005	1995	2005	1995	2005	1995	2005
BW to NW	1,708	1,958	1,065	1,015	1,412	1,485	1,049	1,015
BW to SH	1,665	1,844	1,207	1,203	1,583	1,356	1,079	1,024
NW to SH	0,975	0,942	1,134	1,186	1,121	0,913	1,029	1,009
BW to DE	1,354	1,413	1,052	1,029	1,207	1,196	1,027	0,984
NW to DE	0,793	0,722	0,988	1,014	0,855	0,805	0,979	0,969
SH to DE	0,813	0,766	0,872	0,855	0,763	0,882	0,952	0,961

bold: indicates divergence relative to previous point in time (1991 to 2005; 1995 to 2005); commas are used instead of dots;

[3] EINDH/EINDL: Employees in highly innovative industries divided by employees in low innovative industries; source: SLA (2008), RA (2007), refer to the Appendix for details

[4] ESERH/ESERL: Employees in knowledge-intensive services divided by employees in non-knowl.-intens.- services; source: SLA (2008), RA (2007), refer to the Appendix for details

[5] VAINDH/VAIND: Value added in highly innovative industries divided by total value added in industry; source: SLA (2008), RA (2007), refer to the Appendix for details

[6] VASERH/VASER: Value added in knowledge-intensive services divided by total value added in services; source: SLA (2008), RA (2007), refer to the Appendix for details

Table 3-8 compares **human capital inputs** - in addition to the observed RD staff and RD exp. measures - and **value added outputs** according to the innovation and knowledge-intensity of their sector of employment or turnover. In BW the fraction of the highly innovative to low-innovative employees in industry in 1995 increased relative to NW from 1,7 to about 2 in 2005- indicating divergence. BW's lead also consolidates relative to SH, although less intense. The improved performance of SH relative to NW in innovative industry spells out in value added which reaches about 90% of DE's value opposed to NW's 81%. BW's value added remains about 20% above DE. BW and NW converge in employees in knowledge-intensive to non-knowledge-intensive services. In this measure, BW and SH show no change relative to one another. NW increases the gap in this measure to SH. Relative to DE, BW and NW are marginally above in EINDH/EINDL. In the ten year period NW gained about 2.5% relative to DE and overtook DE; SH lost momentum and fell back. The most interesting finding – see the last column- shows DE with the

highest value added in knowledge intensive services of all units in 2005. BW, NW and SH lose momentum against other Western German Laender not included in the analysis. This finding confirms the hypothesis of superior number of hours worked stemming from different sectoral composition of DE that shows a higher number of workers employed in knowledge intensive services.

Summarizing, BW engages far more in R&D than NW and SH and diverges away from both other Laender. The sectoral analysis suggests BW having a particular advantage in innovative industry over NW and SH, whereas SH has an advantage in innovative industry over NW. NW scores high in knowledge-intensive services relative to SH and converges towards BW with a gap of 1.5% in 2005.

Indicators of R&D and human capital capture well innovative activity that confirms the ranking of the European innovation index (Winkelmann 2006, 26). Within all regions in Europe the three Laender take the rank: BW (1), NW (16), SH (35).⁹⁸ The important role of R&D exp. for the labour supply side – recall figure 2-3 on a national level- can be seen by the following graph for the Laender and DE.

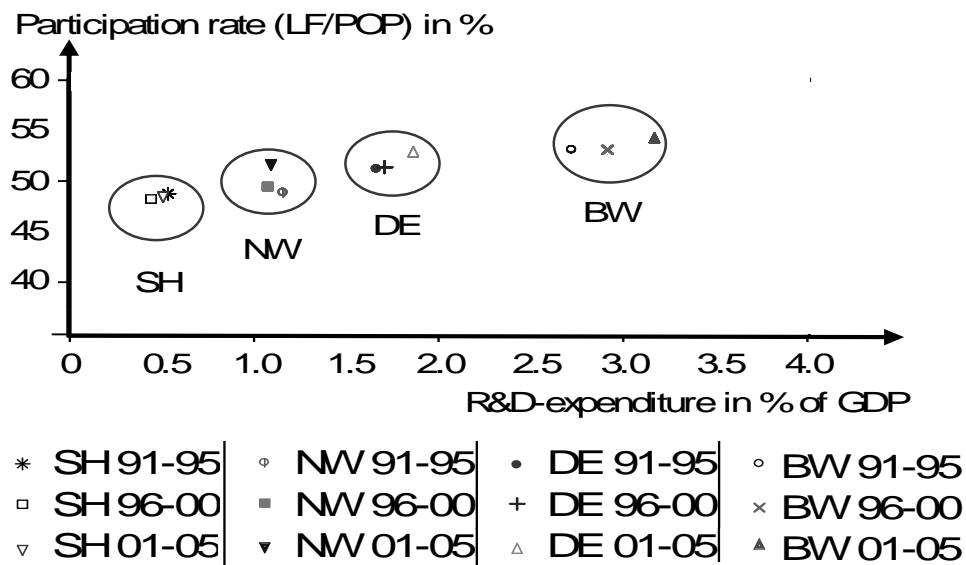


Figure 3-3: R&D expenditure and employment (participation rate) of SH, NW, DE and BW; Source: own calculations based on data from Grenzmann & Kladroba. (2007, 53 & 54); Kreuels (2006, 103) & RA (2007) & MIK (2008)

⁹⁸ Eurostat (2007) confirms the top position of BW, as all NUTS two regions within BW (Stuttgart, Karlsruhe, Tübingen, Freiburg) appear at least in one innovation measure among the European top 15. Refer to the "Science, Technology and Innovation in Europe" pocketbook from EUROSTAT (2007).

In order to see the development over time the data period has been divided into three parts from 1991 until 1995 (sign in graph: circle or star), from 1996 until 2000 (cross or square) and from 2001 until 2005 (triangle). Between 1991 and 2005 in SH, both R&D expenditure and PR reduced slightly. In NW, the PR increased even though R&D expenditure was slightly reduced over time. DE and BW show the ideal development where an increase in R&D led to an increase in the PR in all periods.

Section 3.2 has shown that BW is endowed with greater wealth and blessed with lower unemployment than NW and SH. Divergence in wealth only slightly emanates from higher employment inputs brought by higher labour force participation or a higher employment rate. The predominant difference of BW to NW and SH results from higher labour productivity which stems from a higher effort in innovation resulting in a distinct advantage in highly innovative industries. Comparing the Laender to DE revealed that SH underperforms and BW outperforms DE. NW outperformed DE in the 1970s, however, underperforms in recent years.

Together with the data description in the next chapter, we have the necessary background to turn to the regional labour market model in Chapter 5.

4. Dataset and Sources of the Regional Labour Market Variables

This chapter constitutes a description of the main sources the labour market model in Chapter 5 utilizes. We discuss the geographic unit of analysis; mention the limits of available data and compromises we had to accept. The values of main economic variables of the units under study have been provided in Chapter 3.

4.1. Data units, geographical and time dimension

The **units of study** comprise three characteristic Western German federal states – Laender - (Baden-Württemberg, North Rhine-Westphalia, and Schleswig-Holstein) at a NUTS 1 level and the Western German average⁹⁹ as a benchmark. We decided to carry out the **analysis on a NUTS 1 level** as today's economic and labour market processes are increasingly regionally concentrated which cannot be reflected by an analysis on a national level. Smaller units of analysis – such as NUTS 2 or the so-called “Arbeitsregionen” (regions designed to capture labour market structures) are not used for the following reasons. Clearly, sub-national labour markets are organised at a much smaller geographical scale than that of the NUTS 1 regions that are mostly about 15.000km² to 40.000km² in size for Western Germany. However, smaller sub-regions below NUTS 1 level only rarely cross administrative borders. Therefore, an analysis at a more aggregate – NUTS 1 level loses some degree of variation but does not show an aggregation bias. Further bias could come from spatial effects. Niebuhr (2003, 19) finds in a study about European regional unemployment from 1986-2000 that NUTS 3 regions tend to cluster in space, however: “... [the] high distance decay indicates significant frictional effects of distance. Thus the spatial distance costs are apparently one reason for insufficient equilibrating forces between regional labour markets.” Boltazzi & Peri (2001) confirm the decay in spatial effects for our measure of innovative activity - R&D expenditure. Boltazzi & Peri (2001, 20) observe in their study about the affect of research externalities across space in generating innovations from 1977-1995 in 86 Western European regions: "We estimate this elasticity [elasticity of innovation to R&D done in other regions at various distance] to be positive and significantly different from 0 only for R&D done

⁹⁹ The "VGR der Laender" – our main data source- does not include data for Berlin West after 1992- only Berlin in total. Thus, we exclude Berlin from the analysis also from the Western German average.

within 300 Km's of distance from a region. Its magnitude, though, is quite small: doubling R&D in a region, would increase by 2-3% the patenting activity in another region within 300 km's of distance. Closer to its border (within the first 100 Km's) and for regions of the same country the effect could be as large as 5-6 %." Thus, using the large NUTS 1 regions, accounts for spatial effects while loosing only little exactness.

The used data sets cover different time spans. By harmonizing data, a **time-span from 1975 to 2005** for most variables could be covered. We use yearly averages. At the beginning of the 1970s, some Western German Laender had an unemployment rate of less than 1%. Taking the logarithm of values below 1% would have brought technical difficulties so the analysis starts in 1975 only.¹⁰⁰ In addition, macroeconomic events at the time - such as the oil crisis – tend to inflate data and reduce its exactness. Calculating year-on-year changes manually further increased exactness of the data above the one decimal of the provided growth rates. Detailed data on science, like expenditure on R&D as a fraction of GDP, is only available since 1991 -sometimes since 1995 only - and some only every other year.¹⁰¹

4.2. Data reconciliation and data sources

It had been a time consuming exercise to **reconcile the data** for three major reasons. First, the political change in 1990 changed the unit of reference, from West Germany to combined East and West Germany after 1990. Second, the federal structure of Germany brings along that not all data is collected in the same manner on the regional and national level. Furthermore, constructing a model on a NUTS 1 level created challenges as some variables are only available on a national (NUTS 0) level; especially data before 1990 and for international databases such as the REGIO dataset of the EU or OECD data. Even though addressing more than twenty promising institutions and collected data from those listed below, it was impossible to receive data for the entire time span on a NUTS 1 level for all variables. Hence,

¹⁰⁰ The same technical difficulty – net migration has been negative in some years - motivated us to split up the migration variable into immigration and emigration.

¹⁰¹ Arundel & Hollanders (2006, 2) state: "Up until the 1980s, innovation research was largely limited to case studies or data on the creation of new knowledge, as measured by R&D investments, scientific publications, patented inventions, and the stock of scientists and engineers." Only after the OSLO manual data became available in Europe in an internationally comparable way. Arundel & Hollanders (2006, 2) clarify: "Research using the first CIS [Community Innovation Survey] in 1993 provided empirical confirmation of modern innovation theories that stressed the importance of diffusion and incremental innovation."

we imposed assumptions and rounded off the available data for the missing years.¹⁰² Obviously, every assumption made and manipulation carried out imposes the risk of reducing the quality of data. The manipulations have been made in all conscience and the number of variables manipulated is only a few. The diverse methods of data collection and variable definition had also been accounted for.

The **data** stems from **five** major **sources**. The Regional and National Accounts dataset provided by the Statistical Office of Baden-Württemberg and the National Statistical Office (RA 2007, SBA 2000 & 2008) and the Mikrozensus (MIK 2008)- a continuous household sample survey.¹⁰³ The third source is data exclusively provided by the Research Institute of Occupation and Labour Market (IAB 2008). The fourth is the statistic of science from the Foundation for the German science (data tables in Chapter 3). The fifth is further data exclusively collected and provided by the Regional Statistical Office of Baden-Württemberg (SLA 2008). These sources cover the variables for labour demand and supply. For the matching process we rely on data from Nickell (NIC 2006) who himself relies on OECD (2000), (1997), (1994), Ochel (2001), Nicoletti *et al.* (2000) and Ebbinghaus & Visser (2000), among others.

The following list contains a brief overview of the reconciled datasets:

- NIC (2006): The CEP – OECD Institutions Data Set (1960-2004) William Nickell, Centre for Economic Performance, LSE, September, 2006
- RA (2007): Regional Accounts dataset (Volkswirtschaftliche Gesamtrechnung der Laender, VGRdL).
- SLA (2008): Exclusively calculated and provided by the Statistisches Landesamt Baden-Württemberg based on regional accounts data, Stuttgart 2008
- SBA (2008): Provided by the National Statistical Office, Wiesbaden, 2008: Gesamtwanderungen nach BundesLaendern, Statistisches Bundesamt, VI A, Wanderungsstatistik, Wiesbaden, 2008
- MIK (2008): Mikrozensus- the continuous household survey capturing population and the labour market, involving 1% of all households in Germany every year; provided by the National Statistical Office: Bevölkerung nach Beteiligung am Erwerbsleben und Laendern, Ergebnisse des Mikrozensus, Wiesbaden, 2008
- IAB (2008): Data exclusively provided by the Research Institute of Occupation and Labour Market (IAB Nürnberg).
- SBA (2000): Data obtained from the National Statistical Office (from various Statistical Yearbooks).

¹⁰² Details on the data sources and the completion of data can be found in Appendix A.1.

¹⁰³ The Mikrozensus is the official yearly representative statistics of the population and the labour market, involving 1% of all households in Germany and is provided by the National Statistical Office.

The organisation of the data follows the regional accounts data set (RA 2007) from which most variables emanate. Obtaining the data caused several issues like: MIK (2008) uses a different definition of an unemployed person as RA (2007). For 2005, the MIK (2008) labour force is 2.1 Mio lower than RA (2007), states the Statistisches Bundesamt (2006a). Hence, the labour force variable embraces some fuzziness.¹⁰⁴

The **sectors included** in the analysis are industry and services, for totals also the agricultural sector is included. Link (1996, 45) noted on sectoral data availability: "What we can observe in general is that the recording of data in the third sector can not keep up with the second sector, presumably because of traditional as well as technical reasons inherent in data collection; even though it [the secondary sector] had to give away its dominant position to the tertiary sector since long ago." This is particularly relevant for Baden-Württemberg with its industrial structure (recall Chapter 3 for the sectoral composition) so that being counted as an employee in industry can also include delivering services such as installation of machinery at the customer's side. For disaggregating the sectors by their degree of innovation, we adopted the NACE classification at the two-digit level.¹⁰⁵ Eurostat (2005a,1) notes: "[...] whilst it would be desirable to measure certain activities at the NACE three digit level so as to separate high technology activities from those that are less so, in practice this is not possible. For example, Telecommunications (NACE Rev. 1.1 64.2) and Post and courier activities (NACE Rev. 1.1 64.1) are currently grouped together at the NACE two digit level into Post and telecommunications (NACE Rev. 1.1 64), whereas targeting the Telecommunications sector alone would increase the focus of the statistics." Despite the wide use of the NACE classification obtaining data on a regional level still creates difficulties. Again, internationally comparable data in this degree of detail only starts in the 1990s.¹⁰⁶

For the **method of aggregation**, we adopt the approach of Pesaran *et al.* (1994, 17) and sum up the log of the variables: "The issue of consistent aggregation in the context of a log-linear model has been discussed in the literature [...] and here we simply note that the aggregates employed in (3.2.) [their aggregate labour demand equation] may have some theoretical advantages over standard aggregate measures (i.e. the logarithm of the sum of sectoral employment, wages, or output) when the issue of interest is the analysis of sectoral employment growths."

¹⁰⁴ Again, details about the labour force variable and all other manipulated variables can be found in Appendix A.1.

¹⁰⁵ The classification we use to distinguish employees in highly innovative industry and knowledge intensive services from other employees in the sectors can be found in Appendix A.2.

¹⁰⁶ Even today, some researchers strongly disagree with the regionalisation of CIS (community Innovation Survey) data that was confirmed by a telephone call with the ZEW Mannheim- the institute which collects CIS data for Germany.

4.3. Preparation of variables for estimation purpose

The exact variables for the regional labour market model are the following:

Table 4-1: Variable meaning and source

Variable	Variable Meaning	Data Source
ALMP	active labour market policies	NIC (2006)
CO	coordination of wage bargaining	NIC (2006)
DEFIND(H,L)	value added deflator in industry (at 1995 prices)	RA (2007)
DEFSER(H,L)	value added deflator in services (at 1995 prices)	RA (2007)
E	total employees	RA (2007)
EAGR	dependent employees in agriculture	RA (2007)
EIND(H,L)	employees in industry (with R&D expenditure $\geq 3.5\%$ of sales/ $< 3.5\%$ of sales)	SLA(2008) RA(2007)
ESER(H,L)	employees in services (knowledge-intensive/ non-knowledge-intensive)	SLA(2008) RA(2007)
EP	employment protection (comprises strictness and duration of unemployment benefits)	NIC (2006)
EMIG	emigration out of the region	SBA(2008)
IMIG	immigration into the region	SBA(2008)
LF	labour force	MIK (2008) RA(2008)
LHIND(H,L)	labour hoarding in industry (measured in average hours worked per year)	RA (2007) IAB (2008)
LHSER(H,L)	labour hoarding in services (measured in average hours worked per year)	RA (2007) IAB (2008)
LTAX	labour taxes: payroll taxes, income taxes, consumption taxes; ancillary labour cost	NIC (2006)
PR	participation rate	MIK (2008) RA(2008)
PROF	nominal total profits	RA (2007) SBA (2000)
PROFSE	a proxy for profits per head of the self-employed	RA (2007)
POP	population	RA (2007)
RR	replacement rate	NIC (2006)
SE	self employed	RA (2007)
TE	total employment	RA (2007)
UC	union coverage	NIC (2006)
UD	union density	NIC (2006)
UR	unemployment rate	MIK (2008)
VAIND(H,L)	value added in industry at current prices (with R&D expenditure $\geq 3.5\%$ of sales/ $< 3.5\%$ of sales) (at 1995 prices)	SLA(2008) RA(2007)
VASER(H,L)	value added in services at current prices (knowledge-intensive/ non-knowledge-intensive) (at 1995 prices)	SLA(2008) RA(2007)
WIND(H,L)	per capita nominal labour cost in industry (with R&D expenditure $\geq 3.5\%$ of sales/ $< 3.5\%$ of sales) (at 1995 prices)	SLA(2008) RA(2007)
WSER(H,L)	per capita nominal labour cost in services (knowledge-intensive/ non-knowledge-intensive) (at 1995 prices)	SLA(2008) RA(2007)
i	area index (here: Baden-Württemberg / North-Rhine Westphalia / Schleswig-Holstein/ West Germany)	
t	time index (year)	

All monetary variables are in Euro at 1995 nominal prices. Lacking data on full time equivalent labour units we stick to employment in heads and thus miss the trend of part time employment in recent years. “Employees” refers to dependent employees whereas employment or total employed includes the self-employed. Like employees, also emigration, immigration and population are in heads. The participation and unemployment rate are in percent. Labour hoarding indicates average hours worked per year and employee. NIC (2006) variables are composite measures.

Chapter 3 allows for a reasonable understanding of the data structure so no standard statistics are provided. After knowing the essential of the data we now turn to the labour market model.

5. A Regional Labour Market Model for Germany: Structure and Estimations

In Chapter 5 we estimate the unemployment rate of the three German Laender and DE. An econometric model serves as vehicle for studying relationships between main variables. Understanding the causal relationships and the size of their impact on the unemployment rate are main goals. The more economic structures cluster in space, examining the unemployment rate at a regional opposed to a national level becomes important for regional as well as national policy makers. We start with the framework, modelling strategy and philosophy of the modelling approach. Describing the methodology and structure of the model complements the theoretical part. In the empirical part, we present OLS and SUR estimations.

5.1. The labour market model: methodology, assumptions and structure

Bayoumi (2004, 2) states while explaining the use of GEM- a global economic model: "Academic work in macroeconomics tends to focus on specific issues, such as the consumption function or a new theoretical insight [...] Large macroeconomic policy models [...] are used to quantify the impact of a range of issues within a unified structure, most notably countercyclical macroeconomic policies." The proposed modelling approach lies in between the two poles of investigating a specific issue and investigating a big range of issues. On the one hand the simulation approach resembles that of big macro-models for policy analysis; on the other hand we set a specific focus on elaborating whether a region's innovation structure impacts its reaction to shocks.¹⁰⁷ The modelling strategy fills the gap between traditional regional models and supply-side and economic dynamic issues. The model specification adopts an Error Correction Mechanism (ECM) and has the form of a simultaneous equations model; ECM captures dynamic issues while incorporating long-term relationships. Capturing basic relationships while allowing for feedback mechanisms makes a simultaneous equations model serve best our goals. For considering the increasing relevance of innovation, the modelling strategy incorporates aspects of innovation. The modelling strategy allows

¹⁰⁷ For details about model building recall Chapter 1.

confronting labour markets of regions within a single specification. Applying the same model specification to different regions allows comparing reaction patterns to simulated shocks in Chapter 6.

The majority of literature on economic performance of regions in Germany has mainly focused on convergence issues rather than on **modelling strategies** of labour market models.¹⁰⁸ Besides differences in the level of wealth, fore and foremost, the difference in unemployment rates between Eastern and Western as well as Northern and Southern German Laender dominates the political discussion and the majority of economic literature on German regional economic performance since 1990. Labour market studies are mainly based on individual (individuals or firms) or on national data (see Heckman, 2003) while only few studies have used regionally aggregated data at the level of Laender.¹⁰⁹ Among these, Rau & Werner (2005) provide a good example. They use a shift-share regression approach on a NUTS 3 regional level to highlight regional inequalities in the Western German labour market from 1993 to 2001. However, they focus on employment growth rather than modelling demand and supply of labour. Furthermore, labour market studies on a NUTS 3 level bare the risk of being influenced by commuting.¹¹⁰ Models incorporating labour demand and supply are Modigliani *et al.* (1986) in the Italian case. In their modelling strategies, they also take labour supply as exogenous. Hence, these models are not able to capture distortions induced by a change in the labour force. Baussola (2007) offers a solution to this issue by modelling demand and supply of labour endogenously. His specification allows capturing dynamics of the Laenders' economies, understanding and evaluating policy decisions. We take his specification as a starting point while extending it to incorporate aspects of innovation and the institutional setting.

Besides the explained strategy, we follow the **philosophy** of not modelling the goods and financial market. We rather concentrate on the labour market only.¹¹¹

¹⁰⁸ The topic of convergence or divergence of the Laender in main economic indicators was considered in Chapter 3.

¹⁰⁹ For further examples see Chapter 1.5.

¹¹⁰ see the data chapter for a discussion about the geographical level of analysis.

¹¹¹ Modelling goods, financial markets and the labour market would allow evaluating interactions of simultaneous political reforms (see Muenchau, 2006). Nevertheless, we limit our model to the labour market as being the most urgent issue: Rhein (2006) finds that Germany ranked last in a study evaluating the functioning of labour markets of 28 OECD countries.

Choosing a top-down rather than a bottom-up approach only enables an analysis of the responses to supply and demand shocks. The top-down approach implies that characteristics of regional economies reflect in differences in parameters and not in different model specifications. Different model specifications, would limit the comparison of responses to shocks of the Laender.

The **structure** of the labour market model comprises labour demand, labour supply, the matching factors and aspects of innovation. In capturing labour demand and labour supply¹¹² the model shows a higher degree of detail than Minford *et al.* (1994).

In detail, the structure of the regional model is defined as follows:

$$EINDh(i) = f_1(R_VAINDh(i), R_WINDh(i), LHINDh(i), LTAX(i), UC(i)) \quad (1)$$

$$EINDl(i) = f_2(R_VAINDl(i), R_WINDl(i), LHINDl(i), LTAX(i), UC(i)) \quad (2)$$

$$ESERh(i) = f_3(R_VASERh(i), R_WSERh(i), LHSERh(i), LTAX(i), UC(i), DUM92(i)) \quad (3)$$

$$ESERl(i) = f_4(R_VASERl(i), R_WSERl(i), LHSEERl(i), LTAX(i), UC(i), DUM92(i)) \quad (4)$$

$$PR(i) = f_5(SE/POP(i), E/POP(i), IMIG/POP(i), EMIG/POP(i), ALMP(i)) \quad (5)$$

$$SE(i) = f_6(PROFSE(i), EIND/E(i), ALMP(i)) \quad (6)$$

$$E(i) \equiv EINDh(i) + EINDl(i) + ESERh(i) + ESERl(i) + EAGR(i) \quad (7)$$

$$TE(i) \equiv E(i) + SE(i) \quad (8)$$

$$LF(i) \equiv PR(i) * POP(i) \quad (9)$$

$$UR(i) \equiv 100 * (LF(i) - TE(i)) / LF(i) \quad (10)$$

$$PROFSE(i) \equiv PROF(i) / SE(i) \quad (11)$$

where

ALMP	active labour market policies
DUM92	1992 dummy (zero before 1992, 1 after 1992)
E	total employees
EAGR	dependent employees in agriculture
EIND(H,L)	dependent employees in industry (with R&D expenditure $\geq 3.5\%$ of sales/ $< 3.5\%$ of sales)
ESER(H,L)	employees in services (knowledge-intensive/ non-knowledge-intensive)
EMIG	emigration out of the region
IMIG	immigration into the region

¹¹² Kromphardt (1999) states that employment is predominantly determined by the planned production output of firms- the labour demand side. Hence we model labour demand more detailed.

LF	labour force
LHIND(H,L)	labour hoarding in industry (measured in average hours worked per year)
LHSER(H,L)	labour hoarding in services (measured in average hours worked per year)
LTAX	labour taxes: taxes on payroll, income, consumption; ancillary labour cost
PR	participation rate
PROF	nominal total profits
PROFSE	a proxy for per head profits of the self-employed
POP	population
R_	real value of the variable (nominal value divided by the respective deflator)
SE	self-employed
TE	total employment
UC	union coverage
UR	unemployment rate
VAIND(H,L)	value added in industry at current prices (with R&D expenditure $\geq 3.5\%$ of sales/ $< 3.5\%$ of sales)
VASER(H,L)	value added in services at current prices (knowledge-intensive/ non-knowledge-intensive)
WIND(H,L)	per capita nominal labour cost in industry (with R&D expenditure $\geq 3.5\%$ of sales/ $< 3.5\%$ of sales)
WSER(H,L)	per capita nominal labour cost in services (knowledge-intensive/ non-knowledge-intensive)
i	index of unit (Land: BW, NW, SH or DE)
t	time index (year from 1975 until 2005)

In detail, the equations of **labour demand** comprise two equations for employees in industry and employees in services respectively.¹¹³ Each sector is further disaggregated into two sub sectors. All industrial firms are allocated into one of the industry sub sectors according to their effort in innovation. Those companies spending at least 3.5% of sales on R&D are clustered into the sub sector labelled “highly innovative”. Whereas those companies spending less than 3.5% of sales on R&D are clustered into the sub sector labelled “low innovative”.¹¹⁴ Companies in the services sector are allocated into the sub sector “knowledge-intensive” when they are

¹¹³ We take employees in agriculture as exogenous because of substantial market bias mainly caused by subsidies.

¹¹⁴ The segregation criterion follows the classification of the economic branches (Wirtschaftszweigsystematik) in Germany (see Schumacher *et al.*, 2003) which builds upon the widely used NACE of the European Union (see A). According to Eurostat (2005a) among the indicators available, R & D intensity (i.e. R & D expenditure as a percentage of GDP) is the most recommended for international comparisons [of innovativeness] and is very significant for comparing countries’ R & D efforts.

classified as such according to NACE (Rev 1.1). The other companies in the services sector are clustered into the sub sector “non-knowledge intensive”.¹¹⁵ The exogeneity of sectoral value added, wages, prices and labour hoarding can be justified in terms of model manageability. Bayoumi (2004) suggests ignoring factors that are not of central interest to the issue at hand when constructing macroeconomic models.

Labour supply is modelled by two equations capturing the participation rate and self-employment.¹¹⁶ We find empirical evidence in a number of studies like De Koning *et al.* (2004) that show that participation rate and employment rate are closely related. Economic theory explains this relationship by the discouraged worker effect. The typical neo-classical argument that labour supply depends on individual choice i.e. on opportunity costs (labour (wage)/leisure choice) is expressed by the participation rate¹¹⁷ and the self-employment equation that depend on the wages in industry, services and profits of self-employment respectively.

We model the **matching** to capture the **institutional framework** according to Nickell (2003). He states that the level of unemployment is affected by any variable that influences the ease with which unemployed individuals can be matched to available job vacancies and by any variable that tends to raise wages. Modelling the institutional setting allows the model also to be applied to regions of different countries having a distinct institutional setting. The model specification below only includes policy variables that have at least been once significant in the model estimation. As a consequence, the model includes three of the proposed seven policy variables of Nickell (2003). Monperrus-Veroni *et al.* (2008, 36) state: "Some collinearity problems hamper the construction of a robust model including a wide range of institutions. The statistical improvement realised upon introduction of institutions is rather modest and endogeneity issues make the interpretation of the correlation between institutions and unemployment quite tricky."

The structure follows an error correction mechanism, as already stated. Hence, variables are denoted in differences and are current values or one year lagged

¹¹⁵ As innovation in services is more subtle to measure and there is no single dominant indicator (indicators are for example: Share of employees with higher education, sales of new-to-market goods and services, share of firms that use trademarks) - like R&D expenditure for the industrial sector – we refer to the NACE definition as a classification system which considers manifold factors.

¹¹⁶ Disaggregating labour supply further according to the degree of human capital could be an advancement of the current model. However, we are currently restricted by data availability.

¹¹⁷ The participation rate is defined as the labour force over total population; not as the labour force over working age population.

according to economic theory and their statistical significance. In including the one year lagged value of each explanatory variable we follow Pesaran *et al.* (1994, 16) who state: "The inclusion of lagged employment variables can be justified on the grounds of inertia in revision of expectations, adjustment costs involved in hiring and firing of workers, or aggregation over different labour types." Monastiriotis (2006, 24) also consults to use a lag structure when modelling regional unemployment: "Finally, regional unemployment rates exhibit a notable degree of persistence, implying for the unemployment relationship an autoregressive (lag) structure." Small letters denote the log-value of a variable applied to allow for some basic form of non-linearity in the estimating relationship.

LABOUR DEMAND

$$\begin{aligned} \Delta \text{eind}h_{i,t} = & c_i(1) + c_i(2)*\Delta \text{eind}h_{i,t-1} + c_i(3)*\Delta r_v \text{aind}h_{i,t} + \\ & c_i(4)*\Delta r_w \text{ind}h_{i,t-1} + c_i(5)*\Delta l \text{hind}h_{i,t} + c_i(6)*\Delta t \text{ax}_{i,t} + \\ & c_i(7)*\text{eind}h_{i,t-1} + c_i(8)*r_v \text{aind}h_{i,t-1} + c_i(9)*r_w \text{ind}h_{i,t-1} + \\ & c_i(10)*u_{i,t-1} \end{aligned} \quad (5.1)$$

$$\begin{aligned} \Delta \text{eind}l_{i,t} = & c_i(11) + c_i(12)*\Delta \text{eind}l_{i,t-1} + c_i(13)*\Delta r_v \text{aind}l_{i,t} + \\ & c_i(14)*\Delta r_w \text{ind}l_{i,t-1} + c_i(15)*\Delta l \text{hind}l_{i,t} + c_i(16)*\Delta t \text{ax}_{i,t} + \\ & c_i(17)*\text{eind}l_{i,t-1} + c_i(18)*r_v \text{aind}l_{i,t-1} + c_i(19)*r_w \text{ind}l_{i,t-1} + \\ & c_i(20)*u_{i,t-1} \end{aligned} \quad (5.2)$$

$$\begin{aligned} \Delta \text{eser}h_{i,t} = & c_i(21) + c_i(22)*\Delta \text{eser}h_{i,t-1} + c_i(23)*\Delta r_v \text{aser}h_{i,t} + \\ & c_i(24)*\Delta r_w \text{aser}h_{i,t-1} + c_i(25)*\Delta l \text{hser}h_{i,t} + c_i(26)*\Delta t \text{ax}_{i,t} + \\ & c_i(27)*\text{eser}h_{i,t-1} + c_i(28)*r_v \text{aser}h_{i,t-1} + c_i(29)*r_w \text{aser}h_{i,t-1} + \\ & c_i(30)*u_{i,t-1} + c_i(31)*\text{dum}92_{i,t} \end{aligned} \quad (5.3)$$

$$\begin{aligned} \Delta \text{eser}l_{i,t} = & c_i(32) + c_i(33)*\Delta \text{eser}l_{i,t-1} + c_i(34)*\Delta r_v \text{aser}l_{i,t} + \\ & c_i(35)*\Delta r_w \text{aser}l_{i,t-1} + c_i(36)*\Delta l \text{hser}l_{i,t} + c_i(37)*\Delta t \text{ax}_{i,t} + \\ & c_i(38)*\text{eser}l_{i,t-1} + c_i(39)*r_v \text{aser}l_{i,t-1} + c_i(40)*r_w \text{aser}l_{i,t-1} + \\ & c_i(41)*u_{i,t-1} + c_i(42)*\text{dum}92_{i,t} \end{aligned} \quad (5.4)$$

LABOUR SUPPLY

$$\begin{aligned} \Delta pr_{i,t} = & c_i(43) + c_i(44)*\Delta pr_{i,t-1} + c_i(45)*\Delta(se/pop)_{i,t} + c_i(46)*\Delta(e/pop)_{i,t} \\ & + c_i(47)*\Delta imig/pop_{i,t} + c_i(48)*\Delta emig/pop_{i,t} + c_i(49)*pr_{i,t-1} + \\ & c_i(50)*se/pop_{i,t-1} + c_i(51)*e/pop_{i,t-1} + c_i(52)*imig/pop_{i,t-1} + \\ & c_i(53)*emig/pop_{i,t} + c_i(54)*almp_{i,t} \end{aligned} \quad (5.5)$$

$$\begin{aligned} \Delta se_{i,t} = & c_i(55) + c_i(56)*\Delta se_{i,t-1} + c_i(57)*\Delta(profse)_{i,t} + c_i(58)*\Delta(eind/e)_{i,t} + \\ & c_i(59)*se_{i,t-1} + c_i(60)*(profse)_{i,t-1} + c_i(61)*eind/e_{i,t-1} + c_i(62)*almp_{i,t} \end{aligned} \quad (5.6)$$

MODEL IDENTITIES:

$$E_{i,t} \equiv EINDH_{i,t} + EINDL_{i,t} + ESERH_{i,t} + ESERL_{i,t} + EAGR_{i,t} \quad (5.7)$$

$$TE_{i,t} \equiv E_{i,t} + SE_{i,t} \quad (5.8)$$

$$LF_{i,t} \equiv PR_{i,t} * POP_{i,t} \quad (5.9)$$

$$UR_{i,t} \equiv 100*(LF_{i,t} - TE_{i,t})/LF_{i,t} \quad (5.10)$$

$$PROFSE_{i,t} \equiv PROF_{i,t}/SE_{i,t} \quad (5.11)$$

The model has six stochastic equations, and five identities. **Equations** one through four identify labour demand in industry and services. We adopt the same specification irrespective of the sector, assuming same conditions. Following Pesaran *et al.* (1994, 16) we can adopt such a specification when "[...] employment decisions are made within an industry by cost minimizing firms with identical production functions and the same given demand and factor price expectations." As previously noted, labour demand is split into employees in innovative industries - equation (4.1) - and employees in less innovative industries - equation (4.2). Likewise employees in services are split into employees in knowledge-intensive services – equation (4.3) - and employees in other services - equation (4.4). Again, we take employees in agriculture as exogenous because of substantive market bias.¹¹⁸

¹¹⁸ Also self-employment is taken as exogenous on the labour demand side for the simple reason that demand and supply in the case of the self-employed are the same and hence has not to be modelled on the demand and supply side.

Labour demand - employees by sector - depend on real value added and real wages. By taking real values, the specification already accounts for changes in prices (recall the NAIRU model in Chapter 1). These factors follow the ingredients of a standard inverted Cobb-Douglas production function and are similar to the model of Pesaran *et al.* (1994). Pesaran *et al.* also adopt a general log-linear dynamic specification where labour demand - expressed as the log of man-hours employed at sector i at time t - depends mainly on a lagged employment variable, the log of sector i output at time t , the log of average product real wage per man-hour employed in sector i at time t . We use value added as proxy for output. According to the common neoclassical profit maximisation condition, real wages reflect labour productivity. Including only wages as cost of production can be justified by the declining factor shares for land, natural resources and other production inputs (Jones, 2002). Besides the cost of production, the number of employees also depends on how intense labour is used over the business cycle. De Koning (1989, 155) provides a plausible definition: "Confronting strong output fluctuations, companies are in no position to adjust their labour volume instantly to the technically efficient level. Because of that, they may find themselves with an internal labour reserve at one moment, and be short of labour at another. This phenomenon is called labour hoarding." Hamermesh (1993, 205) describes labour hoarding as: "...a less than proportionate decrease of worker hours in response to a negative demand shock." We follow the proposition of Hamermesh (1993) and measure labour hoarding as average hours worked in difference terms.¹¹⁹

For factors influencing the **matching process**, we refer to Nickell (2003). We divide the factors proposed by Nickell (2003) between the labour demand side - labour taxes and union coverage - and labour supply side - expenditure on active labour market policy- according to the most probable direction of their effect.¹²⁰

¹¹⁹ In the case of the services sector a dummy is included which captures the economic impact of the political change in Germany in 1990. The dummy for 1990 and 1991 has not been significant. It is argued that the political change of 1990 only impacts with a two-year time lag. The fact that the 1992 dummy is significant for the services sector only indicates that after 1990 emigration from Eastern to Western German regions increased considerably and most emigrants (often women) engaged in the services sector.

¹²⁰ From an analysis point of view it would be interesting to include the replacement rate in the PR equation -as a measure for a "policy-induced reservation wage". However, the replacement rate variable in Baden-Württemberg is significant at the 15% level only and in Schleswig-Holstein and North Rhine-Westphalia insignificant. Employment protection, union density and coordination of wage bargaining proposed by Nickell (2003) are not included because of the following reasons: The variable capturing employment protection does not change from 1975 until 1993 in the case of

Labour supply consists of equations (4.5) and (4.6). Equation (4.5) is a modified version of the discouraged worker hypothesis. The hypothesis says that fluctuations in labour supply are triggered by fluctuations in labour demand. A decline in employment decreases labour force participation, while an expanding job market encourages workers to join the active labour force and hence increases the participation rate. The same argument can be applied to emigrants and immigrants. An expanding job market attracts immigrants while a tight job market increases emigration. We model emigration and immigration as a fraction of population.

The second equation on the labour demand side, equation (4.6), models self-employment. Modelling self-employment allows for the fact that workers also have the opportunity to set-up their own business. The first variable to model self-employment is a proxy for profits per head of the self-employed. Using the proxy - set out in equation (4.11) - becomes necessary, as data for profit of the self-employed is unavailable. Including profits as an explanatory variable is based on the neoclassical argument that people's decisions to set-up a company depends mainly on the per-head profits of the self-employed. IFM (2004) confirms the neoclassical argument. In a survey among top business decision makers of small and medium-sized enterprises in Germany, they find the major reason to become self-employed is a higher salary. As a structural variable, the number of employees in industry divided by total employees is included. It captures the marginal component of workers who eventually decide to set up an independent activity. They do so in response to adverse job market opportunities especially in the industry sector.

The **identities** (equations 4.7 – 4.11) complement the model. They provide the connections between the endogenous variables. Unemployment is endogenously determined (4.10) by the interaction of labour supply (labour force (4.9)) and labour demand (total employment (4.8)). Labour supply (4.9) is obtained by multiplying the participation rate as determined in equation (4.5) with total population. Labour demand (4.8) is the sum of employees in industry, services, agriculture (4.7) and the number of self-employed (4.6). Equation (4.11) provides the proxy for the self-employed equation by the ratio of nominal profits to the number of self-employed.

Germany and is insignificant. The union density variable is very similar to the union coverage variable. The coordination of wage bargaining is constant for the entire data period in the case of Germany.

Having defined the model framework, philosophy and model structure, we decide on the estimation method in the next section. Once decided, we estimate the model with the appropriate method.

5.2. Estimations of the labour market model for three Laender and West-Germany

Annual data on a NUTS 1 level from 1975-2005 for three German Laender BW, NW, SH and the Western German average (DE) is used to estimate the model. The regional and time dimension would allow for a panel as well as a time series or cross section estimation. In reference to Barbieri (2008) - who performed a similar exercise for twenty Italian regions - we adopt an unstructured time series estimation approach. Barbieri (2008) compared five different estimation methods and found best results for OLS and SUR. Applying an unstructured estimation approach with OLS and SUR estimation seems, hence, to be most adequate for our model. In confronting estimation results for BW, NW, SH and DE we focus on BW's values as representative of a very innovative region opposed to NW- for a medium innovative region -, SH – for a low innovative region and DE as benchmark. We start with OLS results, then present SUR results before comparing the two.

Restricted data availability – from 1995 until 2005 - for employees in highly innovative industries does not allow differentiating between groups of a sector. Accordingly, employees in services as an aggregate have to be modelled and not split into knowledge-intensive and non-knowledge intensive branches for the same reason. The groups are collapsed into employees in industry (equation 4.1 and 4.2) and employees in services (4.3 and 4.4).¹²¹ Modelling aggregated employees in the secondary and the tertiary sector leaves two labour demand and two labour supply equations (4.5 and 4.6) to be estimated.

¹²¹ We estimated the exact model specification laid out in section 4.2.1 from 1995 until 2005. Unfortunately, the short time period allowed for too few degrees of freedom so that the equations could not be properly estimated. Even after leaving the dummy variable as well as the institutional variables aside, the degrees of freedom still outnumbered the potential of the model.

5.2.1. Ordinary Least Squares (OLS) estimation

We first perform OLS estimation. The well-known OLS methodology allows us to skip the description of the standard methodology. The sign of the results has to be noted, however. Elhorst (2000, 46) states: "Generally, it is difficult to place sign expectations on the explanatory variables of the regional unemployment rate. First, because controversial theories go around on the impact many of these explanatory variables may have and, second, because the overall effect of a particular explanatory variable that jointly affects regional labour supply, regional labour demand and regional wage-setting rate is most uncertain." Even though theoretical sign expectations of explanatory variables are clear, empirical signs may differ. We split the presentation of results into the labour demand and labour supply side.

Labour demand

Looking at table 5-1, the **model fits** labour demand in industry particularly well for BW in the short and long run. Out of ten exogenous variables, eight are significant in BW. In industry, BW, NW and DE are more affected by short-run dynamics than SH. Short -and long- run dynamics drive BW, whereas the small number of significant variables for NW, SH and DE indicates a weaker dependence on long-run values. In industry, labour hoarding and labour taxes are in none of the regions significant. The non-significance signals the relative unimportance of these factors in their used definition. It has to be kept in mind that taxes and labour hoarding are heavily influenced by national specification such as national labour tax rates and laws regulating working time – which are especially strict in the industry sector - so that they may not capture regional specific properties well enough.¹²² UC performs better in significance, except for SH. The importance of unions is expressed by its significance in BW, NW and DE. This importance stems from the (traditionally) strong industrial sector in North Rhine-Westphalia and BW¹²³ where unionism plays an important role. This importance shows up in DE. In SH, UC is not significant mirroring the minor importance of unionism in industry, historically.

¹²² Spitznagel & Werner (2004, 5) state: "In 2003 the German average of agreed weekly working time of a full-time employee was 37.8 hours. The working time differed significantly between regions and sectors, however. [...] The working time reduced by 4 hours per week in Western Germany between 1970 and the mid 90s; since then it remained constant."

¹²³ In 2007, still 33% of employment is in the industry sector (Brenner, 2008, 11)

Table 5-1: OLS estimates for BW, NW, SH, DE - Labour Demand (EIND)

Explanatory variables	Baden-Württemberg		North Rhine-Westphalia		Schleswig-Holstein		Germany (West)	
	coeff.	t	coeff.	t	coeff.	t	coeff.	t
Eq. (5.1 & 5.2):								
$\Delta e_{i,t}$								
const _t	2,4203	(2,363)**	3,078	(2,074)*	0,001	(0,001)	3,424	(2,662)**
$\Delta e_{i,t-1}$	0,4802	(2,751)**	0,552	(2,737)**	0,343	(1,586)	0,608	(3,184)***
$\Delta r_v_{i,t}$	0,2382	(2,602)**	0,293	(2,919)***	0,275	(2,323)**	0,294	(3,192)***
$\Delta r_w_{i,t-1}$	0,2114	(-2,118)**	0,259	(2,298)**	0,122	(1,125)	0,240	(2,556)**
$\Delta h_{i,t}$	-0,0077	(-0,026)	-0,218	(-0,663)	-0,230	(-0,742)	-0,030	(-0,112)
$\Delta tax_{i,t}$	0,0002	(-0,001)	-0,168	(-0,899)	0,147	(0,648)	-0,063	(-0,411)
$e_{i,t-1}$	-0,2814	(-3,753)***	-0,209	(-2,844)**	-0,026	(-0,263)	-0,261	(-3,454)***
$r_v_{i,t-1}$	0,2785	(2,655)**	0,061	(0,457)	0,235	(2,530)**	0,093	(0,745)
$r_w_{i,t-1}$	-0,2379	(-2,453)**	-0,087	(-0,773)	-0,219	(-2,391)**	-0,088	(-0,750)
$uc_{i,t-1}$	0,1186	(2,734)**	0,141	(2,068)*	-0,037	(-0,488)	0,129	(2,695)**
<i>Elasticity</i>								
$\alpha^{[1]}$	-0,0802		-0,392		-0,162		-0,172	
$\beta^{[1]}$	-0,0794		-0,390		-0,144		-0,174	
$\gamma^{[1]}$	1,7982		5,843		2,547		3,616	
SE/MV	-2,5425		-0,802		-1,720		-1,194	
Adjusted R ²	0,717		0,666		0,694		0,736	
F-statistic	8,886		7,216		8,060		9,671	
$LM_1^{[1]}$	-0,136	(0,720)	-0,187	(0,614)	0,115	(0,750)	-0,033	(0,928)
$LM_4^{[1]}$	-0,458	(0,229)	-0,443	(0,243)	-0,773	(0,009) ^[4]	-0,673	(0,047) ^[4]
$LM_W^{[1]}$	16,233	(0,437)	22,533	(0,165)	14,038	(0,596)	18,037	(0,322)

Notes: commas are used instead of dots;

value of the t-statistic in brackets; statistically significant coefficient at the * 90%, ** 95%, *** 99% level; two-tailed test

¹ Long-run elasticity with respect to: VAIND, WIND, UC

² Ratio of the standard error of regression to the mean value of the dependent variable

³ Lagrange multiplier test (Breusch-Godfrey test) for first- and fourth-order autocorrelation (small sample version) and the White test for heteroskedasticity, with the associated p-values

⁴ The Lagrange multiplier test (Breusch-Godfrey test) does indicate serial correlation in these cases. However, the correlogramms indicate that no significant serial correlation exists. The results are likely to be influenced by the small

The most pronounced difference for labour demand in services (see table 5-2) opposed to employees in industry, underline seven significant variables in SH opposed to three in industry. In general, the services sector is more driven by long run than by short-run influences, reflected in a higher number of significant variables in the long than in the short-run. Real value added being significant in the short-run in NW, SH and DE, shows the relative importance of the services sector in these three regions compared to BW where the variable is not significant in the short-run. The value of 0.33 for NW compared to SH's 0.28 indicates that changes in value added lead to more employees in NW where services consist of trading, finance, media and consulting opposed to trading, tourism and public services in SH.

Table 5-2: OLS estimates for BW, NW, SH, DE - Labour Demand (ESER)

Explanatory variables	Baden-Württemberg		North Rhine-Westphalia		Schleswig-Holstein		Germany (West)	
	coeff.	t	coeff.	t	coeff.	t	coeff.	t
Eq. (5.3 & 5.4):								
Δeser_t								
const _t	2,416	(3,744)***	2,109	(2,003)*	3,001	(4,685)***	2,9652	(3,182)***
$\Delta\text{eser}_{i,t-1}$	0,412	(2,551)**	0,419	(2,433)**	0,479	(3,284)***	0,5507	(3,487)***
$\Delta r_v\text{aser}_{i,t}$	0,148	(1,668)	0,330	(2,386)**	0,281	(2,810)**	0,2677	(2,093)*
$\Delta r_w\text{aser}_{i,t-1}$	-0,070	(-0,733)	0,058	(-0,079)	0,038	(0,391)	0,0185	(0,193)
$\Delta\text{lhser}_{i,t}$	0,663	(2,582)**	-0,016	(0,540)	0,218	(2,344)**	0,1664	(0,794)
$\Delta\text{ltax}_{i,t}$	0,220	(1,917)*	0,175	(1,273)	0,117	(1,006)	0,1872	(1,609)
$\text{eser}_{i,t-1}$	-0,319	(-3,054)***	-0,280	(-1,866)*	-0,504	(-4,868)***	-0,3005	(-2,272)**
$r_v\text{aser}_{i,t-1}$	0,356	(5,068)***	0,395	(2,740)**	0,243	(3,437)***	0,3310	(3,160)***
$r_w\text{aser}_{i,t-1}$	-0,257	(-3,109)***	-0,294	(-1,589)	-0,079	(-1,015)	-0,2473	(-1,719)
$uc_{i,t-1}$	-0,084	(-2,728)**	-0,145	(-2,760)**	-0,042	(-1,611)	-0,0951	(-2,633)**
dum92 _t	-0,015	(-2,122)**	0,001	(0,108)	-0,019	(-2,934)***	-0,0004	(-0,057)
<i>Elasticity</i>								
$\alpha^{[1]}$	0,242		0,252		0,178		0,232	
$\beta^{[1]}$	0,256		0,251		0,195		0,250	
$\gamma^{[1]}$	-91,884		-87,395		-57,073		-91,420	
$\delta^{[1]}$	-4,852		-4,374		-2,909		-4,676	
$\epsilon^{[1]}$	-7,952		-7,563		-4,939		-7,9118	
SE/MV	0,290		0,354		0,391		0,3148	
Adjusted R ²	0,687		0,664		0,733		0,694	
F-statistic	7,135		6,530		8,673		7,354	
$LM_1^{[3]}$	-0,285	(0,393)	-0,537	(0,171)	-0,405	(0,242)	-0,205	(0,526)
$LM_4^{[3]}$	-0,301	(0,300)	-0,026	(0,940)	-0,561	(0,066) ^[4]	-0,060	(0,870)
$LM_W^{[3]}$	9,945	(0,934)	21,757	(0,243)	17,122	(0,515)	16,396	(0,565)

Notes: commas are used instead of dots;

value of the t-statistic in brackets; statistically significant coefficient at the * 90%, ** 95%, *** 99% level; two-tailed test

¹ Long-run elasticity with respect to: VAIND, WIND, LHSER, LTAX, UC

² Ratio of the standard error of regression to the mean value of the dependent variable

³ Lagrange multiplier test (Breusch-Godfrey test) for first- and fourth-order autocorrelation (small sample version) and the White test for heteroskedasticity, with the associated p-values

⁴ The Lagrange multiplier test (Breusch-Godfrey test) does indicate serial correlation in these cases, However, the correlograms indicate that no significant serial correlation exists. The results are likely to be influenced by the small size of the sample

In all regions, wages are insignificant in services in the short run. The labour hoarding variable is significant for BW and SH reflecting that here, services companies are smaller than in NW and hence adjust slower to the amount of labour favouring labour hoarding instead of high hiring and firing cost.¹²⁴ Interestingly, labour taxes are only significant in BW. They are positively related to employees in services because many part-time employees -especially in services - do not have to

¹²⁴ 25 of the 50 largest trading companies of Germany are situated in North Rhine-Westphalia (Wirtschaft NRW, 2008)

pay taxes.¹²⁵ An increase in labour taxes in services thus reflects an increase in untaxed employment in services whose social security and pension costs are covered by those having to pay taxes. This phenomenon is much weaker in industry where-even though insignificant- taxes are negatively related to employment. In the long run employees in services in the Laender significantly depend on real value added; strongest in NW (0.40), in BW (0.36), in DE (0.33) and in SH (0.24).¹²⁶ Wages are only significant in BW in the long run. This reflects that also services - like software and IT – in BW are highly export oriented and thus, experience high wage pressure. A significant impact for union coverage on employees in services is found for BW (-0.08), for NW (-0.15) and for DE (0.10). The stronger impact in NW reflects the sectoral composition where services constitute of services that are more traditional. The 1992 dummy - capturing the increase in market size and competition after German unification- is significant in BW and SH. Both Laender have been stronger affected due to export orientation for the former and lack in competitiveness for the latter. In addition, in both Laender in and out migration is high.

For labour demand, we have seen BW depending most on short and long run variables. BW further depends heavily on output in industry in the long run. In BW and SH, wages negatively affect employees in industry in the long run. NW, DE and BW are more affected by unionism than SH. SH depends more on services than on industry in the short and long run. Labour taxes have a mixed affect on employment in industry and services but are only once significant, in services of BW.

Labour Supply

The participation rate and the self-employment equation make up labour supply. From table 5-3 a high dependence of employees on their lagged value for SH can be observed. This suggests a pronounced hysteresis effect.

¹²⁵ Fulltime employment increased in Baden-Württemberg by 2% whereas part-time employment increased by 142% from 1980 to 2006 (Brenner, 2008, 11)

¹²⁶ We have to keep in mind that the figures in services may underestimate effects, as employees in an industry company may well work in services such as financing, logistics or staff but not being classified as employees in services.

Table 5-3: OLS estimates for BW, NW, SH, DE - Labour Supply (PR)

Explanatory variables	Baden-Württemberg		North Rhine-Westphalia		Schleswig-Holstein		Germany (West)	
	coeff.	t	coeff.	t	coeff.	t	coeff.	t
Eq. (5.5):								
Δpr_t								
const _t	-0,529	(-2,410)**	-0,122	(-0,701)	-0,052	(-0,266)	-0,220	(-1,732)
$\Delta pr_{i,t-1}$	-0,027	(-0,175)	-0,385	(-1,668)	-0,727	(-5,643)***	-0,430	(-2,067)**
$\Delta(se/pop)_{i,t}$	0,096	(1,189)	0,164	(1,532)	0,073	(1,089)	0,137	(1,326)
$\Delta(e/pop)_{i,t}$	0,380	(3,313)***	0,422	(3,425)***	0,149	(1,687)	0,419	(4,074)***
$\Delta imig/pop_{i,t}$	-0,028	(-2,401)**	-0,009	(-0,691)	-0,002	(-0,103)	-0,016	(-1,236)
$\Delta emig/pop_{i,t}$	0,042	(2,117)**	0,011	(0,518)	-0,061	(-4,112)***	0,002	(0,096)
$pr_{i,t-1}$	-0,389	(-2,702)**	-0,064	(-0,720)	-0,109	(-1,763)*	-0,186	(-2,075)*
$se/pop_{i,t-1}$	-0,069	(-1,381)	-0,063	(-1,327)	-0,095	(-1,731)	-0,067	(-1,611)
$e/pop_{i,t-1}$	0,203	(1,682)	0,180	(1,652)	0,238	(2,739)**	0,229	(2,309)*
$imig/pop_{i,t-1}$	-0,027	(-2,297)**	-0,030	(-3,199)***	-0,068	(-3,166)***	-0,026	(-2,721)**
$emig/pop_{i,t-1}$	-0,037	(-1,512)	0,018	(0,706)	0,082	(4,064)***	-0,001	(-0,059)
$almp_{i,t}$	0,030	(1,215)	-0,025	(-1,828)*	-0,085	(-6,311)***	-0,022	(-1,432)
<i>Elasticity</i>								
$\alpha^{[1]}$	-0,272		0,466		-0,588		-0,584	
$\beta^{[1]}$	0,902		1,287		0,972		0,968	
$\gamma^{[1]}$	1,183		3,534		-0,398		0,550	
$\delta^{[1]}$	-0,085		-0,221		-0,253		-0,288	
$\epsilon^{[1]}$	1,589		2,764		2,375		2,262	
SE/MV	0,840		0,813		0,619		0,630	
Adjusted R ²	0,740		0,588		0,854		0,716	
F-statistic	8,242		4,631		15,873		7,416	
$LM_1^{[3]}$	-1,144	(0,002) ^[4]	-0,711	(0,017) ^[4]	-0,884	(0,015) ^[4]	-0,160	(0,702)
$LM_4^{[3]}$	-0,640	(0,027) ^[4]	-0,541	(0,025) ^[4]	-0,358	(0,441)	-0,983	(0,200) ^[4]
$LM_W^{[3]}$	16,547	(0,788)	23,542	(0,372)	26,651	(0,225)	18,103	(0,700)

Notes: cammas are used instead of dots;

value of the t-statistic in brackets; statistically significant coefficient at the * 90%, ** 95%, *** 99% level; two-tailed test

¹ Long-run elasticity with respect to: SE/POP, E/POP, IMIG/POP, EMIG/POP, ALMP² Ratio of the standard error of regression to the mean value of the dependent variable³ Lagrange multiplier test (Breusch-Godfrey test) for first- and forth-order autocorrelation (small sample version) and the White test for heteroskedasticity, with the associated p-values⁴ The Lagrange multiplier test (Breusch-Godfrey test) does indicate serial correlation in these cases. However, the correlogramms indicate that no significant serial correlation exists. The results are likely to be influenced by the small size of the sample

BW shows the highest number of significant variables for PR in the short run. In NW and especially in SH long run processes mainly drive labour force participation. The only significant short run variable in the participation rate equation is the employment rate in the case of NW. Its value of about 0.42 for NW and 0.38 for BW indicates a stronger discouragement effect in NW. The discouragement effect in SH and DE is strong in the long run expressed in a significant and high value of the employment rate at about (0.23) for both. The emigration and immigration rates are also often significant, at a small magnitude. The immigration rate in the short run is only significant in the case of BW. Its negative impact on the participation rate

suggests that people who immigrate do not automatically participate in the labour market. They include religious or political refugees who often only possess a very limited working allowance, if any. Emigration is negatively related to the participation rate in SH indicating that people who emigrate out of SH are likely to have had a job in SH. An opposite effect is observed in BW, where the emigration rate is positively related to the participation rate in the short run. This indicates that people emigrate out of BW who did not have a job before such as students, pensioners or former refugees.¹²⁷ In the long run immigration has a mild negative and significant impact in all Laender and West Germany. This is a sign that immigrants do often not participate in the workforce because of unfavourable job-market opportunities for their skills or because German labour market legislation restricts them from participating in the labour market. Opposed to the short run, emigration has a positive effect in the long run in SH. ALMP represents an interesting case. It turns out to be significant in NW and SH, and – even though mild - negatively related to the participation rate. This suggests that spending more in promoting the labour market has a negative effect in those two regions. Fertig *et al.* (2006, 420 & 421) examine the question whether a specific strategy of allocating available budget for ALMP in Germany, at the level of local labour offices, can contribute to a reduction of unemployment in Germany. They find that the specific strategy of how ALMP funds are spent matters: "[...] the intensity of expenditures is almost always statistically insignificant [...] In those cases where it is significant, its impact on the relative net outflows is negative. In the majority of cases, the absolute level of expenditures does not have a statistically significant impact either indicating that it is neither the absolute level of spending nor its intensity relative to the problem group, which is decisive for successful job provision."

Long run dependencies predominantly drive self-employment (see table 5-4). Only in NW, we find a significant variable in the short-run, the lagged SE variable which is positively related to SE. In the long run, SE relates negatively to its lagged value in all Laender and DE. The crowding-out effect explains this result. The early workers, who become self-employed, occupy the markets for self-employed first with relatively low entry barriers. The higher the number of self-employed the more difficult it becomes for the following workers to set up their self-employment activity; they are crowded-out of the market. In addition, workers also take up self-employment activities in response to adverse job-market opportunities - reflected by

¹²⁷ It has to be noted that among the youth of Baden-Württemberg each third person has a migration background (Brenner, 2008, 12). Many of their grandparents who first came to work in the industry of Baden-Württemberg are now as pensioners returning to their country of origin.

the significant negative impact of the structural variable EIND/E. The variable shows significance in all Laender and DE, having the highest value in NW (-0.51), followed by BW (-0.35), DE (-0.28) and SH (-0.24). The strongest affect in NW coincides with the ongoing structural change, followed by BW where even though engaged in innovative industry employment in industry follows a negative trend in the long run.

Table 5-4: OLS estimates for BW, NW, SH, DE - Labour Supply (SE)

Explanatory variables	Baden-Württemberg		North Rhine-Westphalia		Schleswig-Holstein		Germany (West)	
	coeff.	t	coeff.	t	coeff.	t	coeff.	t
Eq. (5.6):								
Δse_t								
const _t	6,726	(3,211)***	13,016	(2,884)***	6,099	(2,445)**	6,068	(1,870)*
$\Delta se_{i,t-1}$	-0,014	(-0,091)	0,599	(2,865)***	-0,020	(-0,104)	0,270	(-1,300)
$\Delta(\text{profse})_{i,t}$	-0,079	(-1,557)	-0,063	(-0,854)	-0,106	(-1,002)	-0,016	(-0,264)
$\Delta(\text{eind/e})_{i,t}$	0,138	(0,473)	0,050	(0,175)	0,092	(0,373)	0,342	(1,340)
$se_{i,t-1}$	-0,474	(-3,533)***	-0,808	(-2,984)***	-0,473	(-2,915)***	-0,348	(-2,070)*
$\text{profse}_{i,t-1}$	-0,068	(-1,507)	-0,227	(-2,409)**	-0,070	(-1,023)	-0,101	(-1,229)
$\text{eind/e}_{i,t-1}$	-0,348	(-2,726)**	-0,506	(-3,027)***	-0,242	(-2,426)**	-0,281	(-1,842)*
$\text{almp}_{i,t}$	0,032	(1,133)	0,113	(2,023)*	0,054	(1,042)	0,058	(1,224)
<i>Elasticity</i>								
$\alpha^{[1]}$	0,010		0,207		-0,0001		0,001	
$\beta^{[1]}$	0,550		5,313		-0,002		0,019	
$\gamma^{[1]}$	-2,127		-34,730		0,017		-0,105	
SE/MV	4,355		1,349		6,449		4,750	
Adjusted R ²	0,632		0,560		0,508		0,684	
F-statistic	7,875		6,082		5,131		9,641	
$LM_1^{[3]}$	1,194	(0,090) ^[4]	-0,092	(0,846)	-1,295	(0,045) ^[4]	0,180	(0,740)
$LM_4^{[3]}$	0,467	(0,121)	-0,332	(0,164)	-0,144	(0,565)	-0,143	(0,658)
$LM_W^{[3]}$	10,220	(0,676)	7,994	(0,844)	15,181	(0,296)	16,934	(0,202)

Notes: commas are used instead of dots;

value of the t-statistic in brackets; statistically significant coefficient at the * 90%, ** 95%, *** 99% level; two-tailed test

¹ Long-run elasticity with respect to: PROFSE, EIND/E, ALMP

² Ratio of the standard error of regression to the mean value of the dependent variable

³ Lagrange multiplier test (Breusch-Godfrey test) for first- and forth-order autocorrelation (small sample version) and the White test for heteroskedasticity, with the associated p-values

⁴ The Lagrange multiplier test (Breusch-Godfrey test) does indicate serial correlation in these cases, However, the correloarrams indicate that no significant serial corelation exists. The results are likely to be influenced by the small

The mild affect in SH reflects the weak dependence on the industry sector. In the long run profits are also significant in NW even though with a negatively. This further indicates that people become self-employed not because they might gain a

higher wage but because of adverse job-market opportunities.¹²⁸ In NW people are further encouraged to become self-employed by training or education reflected by the significant positive impact of expenditure on active labour market policies.

The analysis of the labour supply side shows that BW follows a short-run orientation for the participation rate, whereas the long run dominates the development in SE in all Laender and DE. The ALMP variable does not promote participation in NW and SH in the long run. Self-employment responds to structural difficulties of the labour market - especially in NW- rather than to favourable market opportunities.¹²⁹

5.2.2. Seemingly Unrelated Regressions (SUR) estimation

The SUR estimation complements the OLS estimation in such a way that it tests the model's robustness to the estimation method. The robustness test reveals whether the basic relationships between the exogenous and endogenous variables as well as the rough magnitude of their relationships can be confirmed. We also test whether we find confirmation that the SUR estimates or OLS estimates show a better fit to the model.

In contrast to OLS estimation, the SUR methodology assumes **dependence between the estimated equations**. We can present the estimated equations of our three Laender,

$$\begin{aligned} y_{BW} &= X_{BW} \beta_{BW} + u_{BW} \\ y_{NW} &= X_{NW} \beta_{NW} + u_{NW} \\ y_{SH} &= X_{SH} \beta_{SH} + u_{SH} \end{aligned} \tag{4.12}$$

and the national average:

$$y_{DE} = X_{DE} \beta_{DE} + u_{DE}$$

¹²⁸ We use a proxy for profits only (eq. 5.11) which bases on profits from the national income accounting that experience the following drawback: Grömling (2006, 2) states: "Profits are only statistical residual. [...] the leftover of national income after subtracting wages is considered as profits. In reality, however, this measure [the profits] is used to homogenize the different national income approaches. Therefore, this measure comprises all statistical errors. Sustainable statements to the situation of profits can thus, not be deducted from national income accounting."

¹²⁹ Brenner (2008, 9) states that in Baden-Württemberg in 2006 only 21% of all start-ups have been start-ups where a big business potential can be expected. This supports the results from the analysis that often rather structural than economic reasons lead to the foundation of a company, even in Baden-Württemberg.

Y represents the left-hand side of our two labour demand and two labour supply equations, whereas X stands for the right hand side variables, beta for the coefficients to estimate and u for the error terms. The noted dependence between the equations could exist as dependence between the equations of a single Land (“regional SUR model”) or between the same type of equation – eind, or eser, or pr, or se – between the three Laender (“equation SUR model”). In the case of an equation SUR model, the equation for the national average reveals the relative impact of a Land on the national average. The stronger the correlation of the error terms of a single Land and the national average, the stronger the national average is influenced by this Land.

In the analyses, the following **procedure** was adopted:

- First, we examine whether evidence can be found for a correlation of residuals between Laender that would indicate a similar economic development driven by macroeconomic shocks. In this case, the “equation SUR model” would be preferred over the “regional SUR model”.
- Second, we calculate a correlation matrix of the residuals and perform a Chi² test to know whether a SUR methodology might prove superior to an OLS methodology.
- Third, we estimate the equations by the most adequate methodology and provide estimates of the inferior methodology for comparison.

We estimate the eind equation by least squares for BW, for NW and for SH independently. We do the same for DE. We apply the same procedure for the eser, pr, and se equation for each Land, and DE independently. In order to see whether the residuals are independent or show signs of dependence we look first at the line graphs of the calculated residuals and second at the correlation matrix.¹³⁰

In the case of eind and eser strong **signs of dependence** are observed from the line graph as the residuals of the Laender follow a similar pattern. On the labour supply side the patterns is not that strong. In total, the inspection of the line graph suggests that the equations are not independent from one another; they are rather influenced

¹³⁰ The line graph and the correlation matrix are provided in Appendix A.3.

by the same macroeconomic development.¹³¹ The line graph suggests the “equation SUR model” being an adequate approach to estimate the model and especially to model macroeconomic shocks in Chapter 6.

Now, the correlations between the residuals within the respective equations *eind*, *eser*, *pr* and *se* are calculated. As most correlation coefficients outside the main diagonal in the calculated matrix are – in absolute terms - greater than 0.5, further **evidence for correlation between the Laender’s residuals** can be noted. Finally, we calculate the test statistic, $\lambda_{IND,SER,PR,SE}$, for each equation to confirm or dismiss our findings on dependencies so far. For the *eind* equation, λ_{IND} , takes the form:

$$\begin{aligned} \lambda_{IND} = obs * [& COV^2(RESID_{IND,BW}, RESID_{IND,NW}) \\ & + COV^2(RESID_{IND,BW}, RESID_{IND,SH}) \\ & + \dots + COV^2(RESID_{IND,SH}, RESID_{IN,DE})] \end{aligned} \quad (4.13)$$

Obs is the number of observations, in this case 29 after adjustment.¹³² The null hypotheses of equal residuals within the Laender’s *eind*, *eser*, *pr* and *se* can be rejected if

$$\lambda_{IND,SER,PR,SE} > \chi^2_{N*(N-1)/2; 1-\alpha} \quad (4.14)$$

where α is the level of confidence, as usual. In this case with N=4 degrees of freedom and for $\alpha=0.95$ (0.99), χ^2 has the value of 12.59 (16.81) for *eind*, *eser*, *pr* and *se*. In the industry case the test statistic λ_{IND} equals 38.383; in services λ_{SER} 35.565; for *pr* λ_{PR} yields 23.226 and for *se* λ_{SE} yields 23.661. All values are higher than the critical χ^2 value at the 95 and 99% level of confidence. Hence, the null hypothesis of equal residuals in the regressions is rejected. Consequently, the SUR model outperforms single OLS estimations and thus indicates that it makes sense to estimate the model with a SUR methodology.

Estimating labour demand with the equations 4.1 and 4.2, as well as 4.3 and 4.4 with an “equations SUR methodology” yields:

Labour demand

The labour demand specification in table 5-5 first reveals a large number of significant variables. In industry, BW and DE have eight of ten significant variables. Short run as well as long run relationships drive these two regions. BW shows the

¹³¹ Monperrus-Veroni *et al.* (2008) find that macroeconomic shocks provide a good explanation for changes in the unemployment rate in OECD countries.

¹³² Our dataset covers the years 1975 to 2005, 31 observations in total. The 31 observations are adjusted for the lagged and differenced value which leaves 29 observations in total.

highest persistence in EIND of all Laender and DE with (0.46), DE (0.40), NW (0.37); and in SH the persistence is insignificant. NW and SH are predominantly driven by the long run relationships in the industry sector.

Table 5-5: SUR estimates for BW, NW, SH, DE - Labour Demand

Explanatory variables	Baden-Württemberg		North Rhine-Westphalia		Schleswig-Holstein		Germany (West)	
Eq. (5.1 & 5.2):								
$\Delta eind_t$								
const _t	2,584	(3,826)***	2,544	(2,608)*	0,100	(0,157)	2,763	(3,599)***
$\Delta eind_{i,t-1}$	0,461	(4,112)***	0,370	(2,765)***	0,209	(1,481)	0,400	(3,592)***
$\Delta r_vaird_{i,t}$	0,124	(2,309)**	0,183	(3,067)	0,204	(2,729)***	0,148	(3,169)***
$\Delta r_wind_{i,t-1}$	0,135	(1,863)*	0,238	(2,796)	0,090	(1,131)	0,165	(2,466)**
$\Delta lhind_{i,t}$	0,060	(0,314)	-0,144	(-0,700)	-0,132	(-0,668)	0,011	(0,070)
$\Delta ltax_{i,t}$	-0,076	(-0,556)	-0,151	(-1,044)	-0,006	(-0,034)	-0,119	(-1,000)
$eind_{i,t-1}$	-0,264	(-5,314)***	-0,178	(-3,648)*	-0,027	(-0,442)	-0,207	(-4,529)***
$r_vaird_{i,t-1}$	0,269	(4,080)***	0,185	(2,338)	0,262	(5,082)***	0,220	(3,442)***
$r_wind_{i,t-1}$	-0,242	(-4,018)***	-0,204	(-3,063)	-0,253	(-4,977)***	-0,219	(-3,700)***
$uc_{i,t-1}$	0,106	(3,332)***	0,112	(2,399)*	-0,023	(-0,451)	0,100	(3,139)***
SE/MV	-2,706		-0,868		-1,788		-1,341	
Adjusted R ²	0,679		0,610		0,670		0,667	
Eq. (5.3 & 5.4):								
$\Delta eser_t$								
const _t	2,119	(4,565)***	2,220	(3,211)***	2,811	(6,275)***	2,874	(4,806)***
$\Delta eser_{i,t-1}$	0,280	(2,452)**	0,202	(1,778)*	0,353	(3,399)***	0,265	(2,579)**
$\Delta r_vaser_{i,t}$	0,099	(1,810)*	0,255	(3,630)***	0,202	(3,535)***	0,187	(3,241)***
$\Delta r_wser_{i,t-1}$	-0,018	(-0,266)	0,088	(1,226)	0,093	(1,398)	0,089	(1,454)
$\Delta lhser_{i,t}$	0,484	(2,815)***	-0,074	(-0,621)	0,277	(1,964)*	0,035	(0,293)
$\Delta ltax_{i,t}$	0,119	(1,368)	0,065	(0,656)	0,028	(0,335)	0,075	(0,910)
$eser_{i,t-1}$	-0,324	(-4,300)***	-0,301	(-3,241)***	-0,490	(-6,826)***	-0,310	(-3,936)***
$r_vaser_{i,t-1}$	0,285	(6,190)***	0,375	(4,502)***	0,199	(4,346)***	0,314	(5,460)***
$r_wser_{i,t-1}$	-0,172	(-3,104)***	-0,265	(-2,507)**	-0,034	(-0,649)	-0,221	(-2,848)***
$uc_{i,t-1}$	-0,071	(-3,268)***	-0,146	(-4,449)***	-0,042	(-2,472)**	-0,092	(-4,224)***
$dum92_t$	-0,017	(-3,190)***	-0,001	(-0,171)	-0,020	(-4,259)***	-0,005	(-0,974)
SE/MV	0,313		0,386		0,432		0,362	
Adjusted R ²	0,636		0,599		0,673		0,597	

Notes: commas are used instead of dots;

value of the t-statistic in brackets; at * 10% significant, ** 5% significant; *** 1% significant

Real value added and real wages are not significant in NW. In SH only real value added is significant, not real wages. Both variables show significance in BW and DE, however at low magnitudes. The low magnitudes indicate a smaller dependence on short run development. Employment demand seems to be governed by the long run development. The labour hoarding and labour tax variable are insignificant in all Laender and the national aggregate. The strongest and most significant impact on

employment in industry stems from real value added in the long run for BW, SH and DE when not considering the lagged depended variable. Real wages also significantly negatively affect employment demand in the long run in SH, BW and DE. An increase in wages in the long run hits SH most, BW second most and DE third strongest. In NW except the lagged dependent variables, only UC shows significance. In NW, UC has the strongest positive impact on EIND in the long run.

ESER shows a high level of **persistence** in all Laender and DE, positive in the short run and negative in the long run. SH shows the highest persistence, followed by BW, DE and NW. Real value added in the short as well as the long run is significant for all Laender and DE. Its high magnitude in the long run underlines its importance for ESER. Real wages, in contrast, are insignificant in the short run, whereas their detrimental effect is most pronounced in NW, followed by DE and BW. Labour hoarding plays an important role in BW (0.48) and significantly affects employment in SH (0.28). Significance in the UC variable in all Laender and DE demonstrates its negative impact on employment in the services sector in the long run. The low magnitude of the variable, however, indicates its limited detrimental affect on employment in ESER. The same finding also applies to the dummy variable being significant in BW and SH at a very small magnitude.

Table 5-5 reveals that real value added mainly drives labour demand. Wages show a detrimental effect in the long run for SH, BW, DE in industry and for NW, BW and DE in services. Labour hoarding - the current measure of productivity – is most important for BW's services. BW shows the highest number of significant variables on labour demand and thus follows a path driven by short - as well as strong long run - influences.

Labour Supply

Table 5-6 shows the labour supply side of the SUR estimates. PR shows no significant dependence on its lagged value in the short run, except in SH where dependence is high and pronounced. The change in SE/POP affects significantly BW and SH. In the short run, SE/POP is stronger than in the long run in all Laender and DE. As the variable captures the discouraged worker effect, the effect plays a pivotal role for participation. The immigration variable shows significance in the short and in the long run in NW, BW and DE, in SH not in the short run. The

magnitude is small in the short run and large in the long run for SH. In the short run emigration impacts significantly on PR in BW, NW and SH. In BW and NW the short run impact of EMIG/POP shows a positive sign, in SH emigration impacts negatively on PR. The lagged PR reflects persistence in all Laender and DE. Like for SE/POP the sign is negative and significant for SH only. Emigration negatively influences PR in BW, positively in SH. Likewise the measure for ALMP shows significance only in BW and SH. The effect is positive in BW and negative in SH.

Table 5-6: SUR estimates BW, NW, SH, DE - Labour Supply

Explanatory variables	Baden-Württemberg	North Rhine-Westphalia	Schleswig-Holstein	Germany (West)
Eq. (5,5):				
Δpr_t				
const _t	-0,448 (-2,893)***	-0,120 (-0,955)	-0,011 (-0,076)	-0,180 (-1,999)**
$\Delta pr_{i,t-1}$	0,066 (-0,688)	-0,188 (-1,282)	-0,672 (-7,002)***	-0,164 (-1,400)
$\Delta(se/pop)_{i,t}$	0,125 (2,446)**	0,097 (1,379)	0,089 (1,764)*	0,090 (1,507)
$\Delta(e/pop)_{i,t}$	0,426 (5,202)***	0,435 (4,860)***	0,157 (2,341)**	0,418 (5,831)***
$\Delta imig/pop_{i,t}$	-0,026 (-3,214)***	-0,015 (-1,823)*	-0,002 (-0,165)	-0,023 (-3,020)***
$\Delta emig/pop_{i,t}$	0,038 (3,011)***	0,032 (2,339)**	-0,057 (-5,171)***	0,015 (1,233)
$pr_{i,t-1}$	-0,342 (-3,790)***	-0,110 (-1,724)*	-0,109 (-2,306)**	-0,154 (-2,645)**
$se/pop_{i,t-1}$	-0,051 (-1,439)	-0,030 (-0,887)	-0,080 (-1,923)*	-0,043 (-1,568)
$e/pop_{i,t-1}$	0,157 (1,969)*	0,183 (2,311)**	0,235 (3,564)***	0,173 (2,668)***
$imig/pop_{i,t-1}$	-0,021 (-2,680)***	-0,030 (-4,403)***	-0,061 (-3,806)***	-0,022 (-3,428)***
$emig/pop_{i,t-1}$	-0,034 (-2,070)**	0,000 (0,025)	0,075 (4,992)***	-0,005 (-0,380)
$almp_{i,t}$	0,030 (1,900)*	-0,016 (-1,624)	-0,083 (-8,165)***	-0,011 (-1,121)
SE/MV	0,878	0,865	0,628	0,679
Adjusted R ²	0,716	0,534	0,850	0,670
Eq. (5,6):				
Δse_t				
const _t	6,533 (4,836)***	10,543 (4,183)***	6,174 (3,255)***	6,713 (4,255)***
$\Delta se_{i,t-1}$	0,011 (-0,105)	0,397 (3,217)***	0,101 (0,694)	0,188 (1,659)
$\Delta(profse)_{i,t}$	-0,126 (-3,181)***	-0,120 (-2,478)**	-0,211 (-2,585)**	-0,096 (-2,523)**
$\Delta(eind/e)_{i,t}$	0,028 (0,128)	0,008 (0,040)	0,048 (0,252)	0,143 (0,858)
$se_{i,t-1}$	-0,463 (-5,252)***	-0,674 (-4,388)***	-0,466 (-3,766)***	-0,392 (-4,742)***
$profse_{i,t-1}$	-0,062 (-2,171)**	-0,159 (-3,052)***	-0,082 (-1,556)	-0,098 (-2,431)**
$eind/e_{i,t-1}$	-0,325 (-3,959)***	-0,397 (-4,272)***	-0,224 (-2,955)***	-0,277 (-3,711)***
$almp_{i,t}$	0,025 (1,251)	0,077 (2,417)**	0,062 (1,529)	0,051 (2,092)**
SE/MV	4,520	1,457	6,718	5,283
Adjusted R ²	0,604	0,487	0,466	0,609

Notes: commas are used instead of dots;

value of the t-statistic in brackets; at * 10% significant, ** 5% significant; *** 1% significant

Again, the SE estimation indicates that the decision to become self-employed emanates from adverse job market opportunities rather than from the desire to increase one's salary. In the long run, the structural variable - capturing the number of employees in the industry sector to total population - impacts highest on SE. The fewer people that are employed in industry the more people become self-employed. In the short and in the long run, profits impact negatively on self-employment. Again, it is important to note that the measure of profits is only a proxy. The self-employed show a high degree of persistence in the long run except in SH. In the long run SE lagged negatively correlates to its current change. In the short run in NW, SE follows a significant, positive relationship to its current value. Interestingly opposed to PR, for SE the ALMP variable shows significance in NW and DE.

The estimation of labour demand shows the relevance of structural variables in analysing labour supply effects. For the PR the employee ratio and for SE the EIND/E is the main driving forces. The Laender and DE follow similar patterns with different magnitudes. The most pronounced difference in significant variables emanates from the migration behaviour and expenditure on ALMP.

5.3. Comparison between OLS and SUR estimates

Comparing OLS and SUR estimates reveals whether the estimated magnitudes and significance capture the underlying relationships of the variables.

In the SUR case, the total number of significant variables- looking at the t-statistics- on the labour demand side slightly outnumbers those in the OLS case: 54 to 52. The biggest difference on **significant variables** lies on the labour supply side where for OLS 36 and for SUR 54 variables are significant. In detail, we observe that on the labour demand side, nine differences in significance are observed. Seven out of nine are differences in real value added or wages, mainly in NW and DE. In the SUR estimation, labour taxes are once insignificant in BW and UC is once significant in SH opposed to the OLS case. On the labour supply side, the SUR estimation demonstrates its particular strength expressed in 18 significant variables more opposed to OLS. In the PR case, the difference is most pronounced in BW and NW. In SE, the difference is highest in BW and DE.

The **sign of the variables** is always identical where variables are significant.

The **magnitude of the variables** differs between OLS and SUR estimates. The magnitude of the SUR estimates falls short of the value of the OLS estimates. The difference adds up to about 20%, in most cases; in very rare cases, OLS estimates can reach nearly the double value of SUR estimates. In addition, a number of cases where values are nearly identical can be found.

Summarising, we can state that the SUR model outperforms the OLS model in significance, especially on the labour supply side. All the signs on the labour supply and labour demand side are equal where variables are significant. In the majority of cases, the magnitude of the estimated variables only differs to a small extent. Besides the significance, the Chi² test, the line graph and the correlation matrix of the residuals already revealed the better match of the SUR model with the underlying relationships. We conduct a simulation exercise of both models; prefer the SUR model, however, to perform the simulation of shocks in the second part of the next chapter.

6. Simulating Economic Shocks and Economic Policy Measures on the Labour Markets of Baden-Württemberg, North Rhine-Westphalia and Schleswig-Holstein

The model simulation aims at providing insight into how good our estimations capture the real data. After a dynamic deterministic simulation of the OLS as well as the regional SUR model, we model macroeconomic shocks with the SUR model. We observe the reaction of employment within the SUR model to labour demand, labour supply as well as policy-induced shocks. The shocks represent policy actions taken by the policy maker as well as shocks dwelling from the economic environment of the Land. Analysing the reaction pattern provides useful insights for the policy decision maker. The pattern reveals how and how strong a shock affects the Laender in our sample. The analysis of the Laender under study – Baden-Württemberg (BW), North Rhine-Westphalia (NW), Schleswig-Holstein (SH) - in comparison to Germany (DE) as a whole shall further reveal whether distinct regional reaction patterns exist. We set a special focus on analysing BW as the most innovative unit in the sample.

6.1. Dynamic deterministic simulation

The dynamic deterministic simulation comprises the entire data period from 1975 until 2005. Simulation results for each of the three regions can be found in Appendix A.4. Besides the graphs, the capability of the OLS as well as the SUR estimation method to capture the historical pattern of main economic variables of our model is evaluated. The **Root-Mean-Square-Error** (RMSE) and **Theil's Inequality Coefficient** (TIC) serve as tools for evaluation.

The following formula defines the RMSE:

$$RMSE = \left\{ \frac{1}{T} \sum_t (y_t - \tilde{y}_t)^2 \right\}^{1/2} \quad (5.1)$$

y_t refers to the values from the data sources of the examined variables (e.g. EIND, ESER, PR, SE, TE, UR), \tilde{y}_t to the simulated values of these variables, T to

the dimension of the time series (31, adjusted 29) and finally, the sum is taken over the simulation period ($t=1977, 1978, \dots, 2005$) before taking the root of the result.

Theil (1961) provides the TIC index, with $0 \leq TIC \leq 1$:

$$TIC = \frac{\left\{ \frac{1}{T} \sum_t (y_t - \tilde{y}_t)^2 \right\}^{1/2}}{\left\{ \frac{1}{T} \sum_t y_t^2 \right\}^{1/2} + \left\{ \frac{1}{T} \sum_t \tilde{y}_t^2 \right\}^{1/2}} \quad (5.2)$$

The TIC provides rescaled and comparable values in a range between zero (perfect fit) and one (worst fit). The main use of the TIC in the analysis comes from the fact that the fit between variables irrespective of their magnitudes can be compared. Therefore, all information about the magnitude of the measured error is lost. The RMSE, hence, complements the measure of goodness of fit as it keeps the information about the size of an error. Both measures apply to a univariate analysis, perfect to confront the fit of single variables to one another. TIC and RMSE capture correlations neither across simulation errors nor across different temporal horizons. We apply the measures to all three Laender and Germany as a whole. The application of the measures to the main variables allows for adequacy and clarity. In addition, we are interested whether the estimates are unbiased. To test for a possible bias in the error term we apply the widely used **Mincer Zarnowitz test** (Mincer & Zarnowitz, 1969) and Wald test (Wald, 1943) which controls whether the Mincer-Zarnowitz coefficient is significantly different from one.

6.1.1. The simulation's goodness of fit (OLS and SUR)

The dynamic deterministic simulation based on the OLS and SUR results in Chapter 5.2.1 and 5.2.2 show an overall good fit. Again, the graphs of the simulation can be found at the end of this chapter. The tables below present the RMSE and TIC results for the main variables. The **fit of the model** can be considered as good according to the graphical as well as the calculated measures of goodness of fit. We observe in the graphs that the simulation captures well the long run trend for both OLS and SUR estimates. In the short run, estimates tend to overestimate the values in downturns and to underestimate values in upturns, especially for the unemployment rate.

Table 6-1: Measures of Goodness of Fit (TIC & RMSE) for OLS: Estimations of BW, NW, SH, DE

	Baden-Württemberg		North Rhine-Westphalia		Schleswig-Holstein		Germany (West)	
	TIC	RMSE	TIC	RMSE	TIC	RMSE	TIC	RMSE
EIND	0,0056	21816,0	0,0078	43574,8	0,0070	3949,7	0,0053	103962,4
ESER	0,0030	14770,2	0,0034	30186,5	0,0033	4774,4	0,0038	124315,2
PR	0,0021	0,0022	0,0034	0,0033	0,0020	0,0019	0,0022	0,0023
SE	0,0057	6178,4	0,0089	12976,3	0,0050	1420,9	0,0050	32922,7
TE	0,0027	27019,2	0,0039	61444,0	0,0029	6789,2	0,0029	172982,6
UR	0,0386	0,4195	0,0319	0,5199	0,0348	0,5888	0,0352	0,4981
	MZ ^[1]	Wald ^[2]	MZ ^[1]	Wald ^[2]	MZ ^[1]	Wald ^[2]	MZ ^[1]	Wald ^[2]
EIND	0,9708	0,5736	0,9652	0,155	0,916327	0,0134	0,969907	0,2478
ESER	0,9994	0,9882	1,0024	0,9343	1,000128	0,9998	1,004261	0,8407
PR	1,0159	0,4796	1,0266	0,3754	1,021174	0,014	1,012876	0,3745
SE	0,9638	0,5509	0,9706	0,8215	0,990914	0,9717	0,940648	0,1775
TE	1,0061	0,8035	1,0384	0,1356	1,009975	0,5528	1,019046	0,2997
UR	1,0209	0,8709	1,0368	0,5946	1,026467	0,7455	1,026489	0,8328

Notes: commas are used instead of dots;

¹ Coefficient of the Mincer-Zarnowitz regression, if > 1.05 or < 0.95 the estimate could be biased at 95% level of confidence;

² Probability of the f statistic of the Wald test, if < 0.05 the Minzer Zarnowitz estimate is biased at 95% level of confidence;

Table 6-2: Measures of Goodness of Fit (TIC & RMSE) for SUR: Estimations of BW, NW, SH, DE

	Baden-Württemberg		North Rhine-Westphalia		Schleswig-Holstein		Germany (West)	
	TIC	RMSE	TIC	RMSE	TIC	RMSE	TIC	RMSE
EIND	0,0068	26638,5	0,0090	49923,3	0,0071	4048,8	0,0076	150922,4
ESER	0,0036	18073,1	0,0042	37237,0	0,0038	5556,0	0,0042	137093,5
PR	0,0025	0,0027	0,0039	0,0038	0,0024	0,0024	0,0029	0,0029
SE	0,0060	6470,1	0,0075	10843,8	0,0059	1665,2	0,0058	37558,0
TE	0,0037	37138,6	0,0050	79203,2	0,0033	7807,6	0,0043	255036,0
UR	0,0472	0,5119	0,0398	0,6464	0,0373	0,6297	0,0417	0,5887
	MZ ^[1]	Wald ^[2]	MZ ^[1]	Wald ^[2]	MZ ^[1]	Wald ^[2]	MZ ^[1]	Wald ^[2]
EIND	1,0223	0,6549	0,9655	0,2065	0,9386	0,0725	0,9731	0,4395
ESER	1,0018	0,9550	1,0051	0,7883	1,0015	0,9887	1,0059	0,7458
PR	1,0309	0,2018	1,0532	0,0328	1,0321	0,0081	1,0367	0,0538
SE	0,9686	0,6514	0,9945	0,9793	0,9877	0,9488	0,9689	0,5895
TE	1,0157	0,5143	1,0514	0,1184	1,0261	0,1677	1,0295	0,2707
UR	1,0669	0,4770	1,0993	0,1934	1,0858	0,2840	1,1153	0,1396

Notes: commas are used instead of dots;

¹ Coefficient of the Mincer-Zarnowitz regression, if > 1.05 or < 0.95 the estimate could be biased at 95% level of confidence;

² Probability of the f statistic of the Wald test, if < 0.05 the Minzer Zarnowitz estimate is biased at 95% level of confidence;

The TIC reveals the good fit of the estimates showing values at the third decimal only, except for UR. Unemployment rate estimates are about ten times less precise than the estimates of the other variables. The simple reason behind this finding is that within the unemployment rate all estimation errors add up because the unemployment rate itself is endogenously determined by interaction of labour demand and supply. It can be further observed from tables 14 and 15 that the RMSE

values reach up to 172 983, 255 036 in the case of total employees in DE for OLS and SUR. In SH, the RMSE of the same variable adds up to 6 789 for OLS and 7 807 for SUR only. The example clearly demonstrates what we noted previously, that the RMSE complements the TIC by providing absolute numbers. In the OLS case, the Mincer-Zarnowitz test for EIND in SH finds evidence of a small consistent bias of overconfidence – at the 95% level. For the PR of SH it reveals a too-timid estimation. In the SUR case, the Mincer-Zarnowitz test indicates – at the 95% level of confidence - for PR in NW and SH again a timid estimation overestimating downturns and underestimating upturns. In evaluating the errors the statement of Baussola (2007, 29) clarifies: “It is worthwhile underlining the fact that this is a dynamic simulation, and thus it implies that forecasting errors are cumulated through time. This issue is particularly relevant in the present case, as it uses an error correction specification that needs an endogenous variable lag structure in each equation. This consideration may explain some specific results of the simulation exercise, which, although satisfactory on the whole, presents in some cases a less satisfactory performance.” Overall, the results of the OLS and SUR estimation are similar.

6.1.2. Comparison of OLS and SUR simulation

When comparing the simulations based on OLS and SUR estimation, OLS estimates show a better fit of the model for the TIC and RMSE. The better fit reflects the higher R^2 from the single equations (see Chapters 5.2.1 for OLS and 5.2.2 for SUR). The single TIC and RMSE of table 6-1 and 6-2 confirm this finding on the level of each variable. The TIC and RMSE values of the OLS estimates are for each single variable below those of the SUR model, except for SE in NW. The ability of the SUR model to capture labour supply more precisely than labour demand is confirmed by the smaller aggregate TIC values for PR and SE compared to EIND and ESER. Even though the OLS estimation is superior to the SUR estimation, the difference in PR and SE – looking at the TIC- is less pronounced. The finding applies especially to NW and to DE and BW.

The fit of the OLS model is superior to the fit of the SUR model in the estimation as well as the simulation. Especially on the labour demand side, the fit of the OLS model exceeds the SUR model. The better fit, however, comes at the cost of a lower explanatory power of the exogenous variables. From Chapter 5.2.1 and 5.2.2 we clearly observe a much higher degree of autocorrelation in the OLS case.

The additional explicative power from other exogenous variables is thus, significantly lower in the OLS case. The single estimation of the equations proved inferior when performing the Chi² test in Chapter 5.2.2. Hence, even though quantitatively the OLS model proves to be superior, qualitatively and from a structural perspective the SUR model is more adequate for the shock analysis in the next section.

6.2. Simulation of external economic shocks and policy measures

After the dynamic deterministic simulation carried out in the previous section, we first look at what determines shocks and what are the reactions to shocks. Subsequently, we state the methodology of modelling shocks, before we simulate different exogenous shocks and observe the Laender's and Germany's reaction.

6.2.1. Sources of and adjustments to shocks

The brief discussion of factors leading to shocks and typical reactions to shocks provides the background to interpret the Laender's and Germany's reaction patterns to shocks in section 5.2.3.

Bean (1994) provides a good **overview of sources of shocks**. He finds that labour demand shocks mainly depend on nominal inertia in prices and wages that means their transmission depends on the reaction patterns – expressed by the slope of employment and wages to changes in inflation. If there is high nominal inertia in prices and wages - prices and wages are preset to a large extent - then there should be high unemployment. If the slopes of the price-employment and wage-setting schedules are steep, then a negative demand shock can affect the unemployment rate to a small extent only. However, Bean (1994, 587) continues by stating: "Because a purely nominal demand shock has real effects only so long as wage and/or price adjustment is incomplete and the degree of nominal inertia seems to be relatively short lived, demand shocks can only be an explanation for the persistent unemployment if there is some other mechanism that ensures the effects are propagated over time." He provides the following range of possible mechanisms at work.

A first explanation could be a slowdown in productivity. The general argument is that once labour productivity decreases and wage aspirations do not decrease

instantly by the same amount, wages increase relative to productivity and hence cause unemployment.

Another possible mechanism is taxes and import prices. Rising taxes have the potential to decrease disposable income (reduce consumption and demand) or put pressure on inflation as companies want to set higher price to retain the profit margin. Furthermore, increasing prices could also increase the reservation wage by increasing the real value of leisure relative to decreased net-wages after taxes. Rising import prices lead to an increase in prices for imported production inputs or decrease the possibility of exporting goods that both have a negative impact on labour demand.

A third mechanism could be worker militancy. Increased worker militancy expressed by stronger union power (union coverage, union density) could lead to higher wage costs and reduce employment.

A fourth mechanism is unemployment benefits. The higher unemployment benefits the higher the reservation wages. The reservation wages triggered by unemployment benefits depend on coverage, duration, eligibility conditions and height of the benefits. Unemployment benefits can be a major obstacle of a smooth matching between unemployed workers and firms willing to employ workers. They can also increase the duration of unemployment.

The mismatch as such is the fifth mechanism Bean (1994) describes as a factor triggering unemployment. If the vacant jobs and the unemployed workers do not match, unemployment will be high despite high labour demand. A central issue here is education and human capital but also attitudes such as travel time or the willingness to relocate.

All these factors influence unemployment on the labour demand and supply side. Further shocks can come from labour market regulations and inflexibility. As labour market regulations increase by minimum wages that are more generous¹³³ or higher employment protection, the flow of labour is tightened and therefore the matching of jobs and workers is hindered. Lazear (1990) finds in a study for 22 OECD countries that severance pay reduces employment and raises unemployment.¹³⁴ A further shock can be an increased mark-up induced by sector

¹³³ Brown (1988) reviews studies on minimum wages. The studies find that a ten percent increase in the minimum wage reduces teenage employment by one to three percent.

¹³⁴ Lazear's regression includes little else that could explain the rise in unemployment so that the relevance of his result is not straightforward.

concentration. An increased mark-up leads to a downward movement in the price-employment schedule and an increase in the equilibrium unemployment rate. In addition, an increase in the real interest rate can trigger an increase in the price mark-up. As already noted, movements of the price-employment schedule and the wage-setting schedules can transmit these shocks.¹³⁵ This is the reason why one can expect shocks to impact over time, even when the shock as such was a fugacious event.

Once a shock affects a region, **adjustment mechanisms** take place. Möller (2001) provides a list of the most important adjustment mechanisms of a region in response to an adverse shock, a decrease in aggregate demand.

First, he mentions mobility of labour that, in the form of commuting and migration, reduces labour supply and hence, pre-shock employment might be restored. Blanchard & Katz (1992, 56) state: "To the extent that labour mobility is the main source of adjustment in the United States, this suggests that shocks will have larger and longer lasting effects on unemployment in Europe." Decepcion & Fatas (1995) confirm the finding of Blanchard & Katz that in response to an economic shock, migration behaviour is of minor importance in the case of European regions. What reacts in response to a negative economic shock is participation behaviour. Participation can be affected by the income or substitution effect and thus participation can be positively or negatively affected. Empirically it can often be observed that the discouraged worker effect dominates so that participation declines as a response of a negative economic shock. Another mechanism is the reduction of real wages and product prices as a response of higher unemployment. Workers are less likely to find a job, reduce their wage aspiration that lower labour costs of firms and allows firms to reduce prices. Lower prices finally lead to a recovery of demand and new employment. The economic contraction leads to lower prices of non-tradables and consequently by lowering the cost of living, pressure on wages is further reduced so that they can adjust to a lower level. Lower wages may then stipulate employment. The exact adjustment mechanism -once again- also depends on migration behaviour. Möller (2001, 32) finds in his analysis of regional adjustment processes "[...] that the outside option as an important determinant of wage-setting depends on the possibility to migrate. This creates interdependency with variables and institutional conditions in other regions that are important for the migration decision. Through its influence on labour supply

¹³⁵ The explanation and phenomena of persistence mechanisms can be found in the theory of unemployment in Chapter 2.1.

and unemployment, migration feeds back to regional wage setting." The effect on capital flows could be positive if main input prices of production – the real wages of workers - decrease. However, if the economic shock negatively affects the expectation of economic development of the region, capital flows might not increase. The effect on productivity should be positive as outside options for the workers deteriorate. Möller (2001, 11) summarises: "The complexity of regional adjustment after a regional shock is evident. Moreover, all what we know about regional development points to the fact that catch-up processes after deep regional crises are slow [and...] the duration of these amendment periods are better measured in decades than in years [...]" The speed of reaction of a region to a shock decisively depends on the stated propagation mechanism, or hysteresis. Möller (2001, 32) states: "[...] regional production and the potential labour supply [...] are influenced by the initial conditions and, therefore, by temporary shocks. In other words, these variables are path-dependent [...]. More specifically, it can be shown that temporary shocks in the price level, in labour supply and unemployment can affect the economic power of the region in the long run, while temporary wage and production (demand) shocks are irrelevant in this respect." Obstfeld & Peri (1998) add that regional transfer payments may further delay regional adjustment processes. More general, Bayoumi (2004) states in a GEM model that the speed of adjustment of a model does depend on the institutional setting of the country. Besides the different duration of the shocks, the German unemployment rate, in general, shows high sensitivity to shocks, as stated by Monperrus-Veroni *et al.* (2008). Scarpetta (1996, 71) complements the picture of high sensitivity to shocks: "High levels of unemployment benefit entitlements are likely to lead to higher levels of unemployment and reduce the speed of labour market adjustment after an exogenous shock." Hence in the following shock exercise we can expect high initial reactions to shocks but only slow adjustment thereafter.

6.2.2. Methodology of the shock exercise

We simulate both demand and supply shocks. A demand shock directly affects the level of activity whereas a supply shock affects the level of relative prices and through this mechanism the level of activity. In detail, demand shocks show up in exogenous changes in value added in industry and services. The sectoral changes then constitute total aggregate demand in our closed economy. Supply shocks are recognised by changes in the cost of labour relative to product prices. The changes

trigger substitution mechanisms between capital and labour. Both shocks have the potential to impact on immediate as well as on long-run employment.

A further kind of shock comprises a productivity shock (TFP shock). Increasing productivity does not increase or decrease production inputs at once. However, relative to the change in output and the elasticity of output it changes the effects that production inputs can have.¹³⁶

Policy-induced shocks constitute another category of shocks. Examples in our case comprise a change in labour taxes, changing union coverage or changing expenditure on active labour market policy. The specific nature of a policy shock allows the shock to impact on the labour demand, the labour supply side or by affecting the matching mechanism between both sides of the labour market.

Again, the diverse feedback mechanisms in a model comprising labour demand, labour supply and the institutional setting make it difficult to evaluate the impact of shocks in general. Therefore, we reduce complexity and increase clarity by **modelling one shock at a time** instead of modelling various shocks simultaneously. In order to capture the impact a single variable has, we only increase one variable at a time by 1%. Once a shock is induced, it will be held constant – in absolute terms – over the simulation period of 15 years. We refer to the ceteris paribus assumption when analysing the effect of a shock. In other words, we assume that except for the changed variable all other variables remain unchanged for the simulation period. The impact of each shock will be assessed by looking at the participation rate (PR) as representative of the labour supply side, total employment (TE) as representative of the labour demand side and the unemployment rate (UR) as the measure we are most interested in. Appendix A.5 provides the reactions of the three variables.

6.2.3. Value added shocks

The positive shock in **value added** (exogenous demand shock induced by an increase in exports, for example) in industry increases sectoral employment and total employment as well as the participation rate (see Appendix A.5). The increase in total employment is much shorter lived than the increase in participation so that after one

¹³⁶ According to (Blanchard 2006) a historic example is provided by the 1970s when Harrod-neutral technological progress (division of the Solow residual by the labour share) declined from about 5% in the 1950s and 1960s to about 2% and unemployment increased.

to three periods, unemployment rates exceed pre shock rates for NW, SH and the German average (DE).

Table 6-3: Reactions to a shock in Value Added in Industry (VAIND)

	TE reaction			PR reaction			UR reaction		
	SR*	MR**	LR***	SR	MR	LR	SR	MR	LR
Baden-Württemberg	+	+	°	+	°	°	-	-	°
North Rhine-Westphalia	+++	++	°	+++	++	+	---	++	++
Schleswig-Holstein	+	-	°	++	+	+	-	++	+
Germany (West)	++	+	°	++	+	°	--	+	+

*SR = short run (period 0-3); **MR= medium run (period 4-8); ***LR=long run (period 9-15)

+++ value is very strongly above / ++ strongly above / + above pre shock level

° value is at pre shock level

--- value is very strongly below / -- strongly below / - below pre shock level

In the case of a value added shock in industry (VAIND), NW shows the strongest increase in TE in the short run. Then employment sharply declines in the medium run to reach the average after about eight to twelve periods. BW shows the least pronounced reaction where total employment only increases about 0.1% above the pre shock level before slowly declining to reach pre shock employment after about eight periods. In SH employment increases at the beginning, then falling sharply and becoming negative between periods two and six before performing slightly above DE's level after seven periods.

PR reacts more slowly to the positive shock in value added in industry than in TE. It reaches its peak with a delay of one to two periods. Again, NW shows the strongest reaction where PR increases about 0.65% after one period. Then it declines strongly until the 5th period before the decline becomes less pronounced. At the end of the simulation period - after 15 years - it remains 0.17% above pre-shock level. The strong reaction in NW confirms the high-discouraged worker effect. In SH, the participation rate increases to reach a peak of 0.2% after one period before it declines while fluctuating. The decline is much less pronounced than in NW so that it remains at about 0.1% of pre-shock level after fifteen periods. Again, BW shows the least reaction. Its PR reaches a peak of 0.06% after three periods and then declines slowly and smoothly to reach pre-shock level after six periods already.

The PR and TE developments are reflected in the development of UR. Again, the most distinct reaction - highest decrease – in NW followed by DE, SH and BW

can be found. As TE declines much faster than the induced increase in PR, the decrease in unemployment is strongest immediately after the shock for NW and SH. The UR of SH increases immediately. The maximum of 0.3% above pre shock level is reached after three periods. Thereafter it declines to remain 0.06% above pre-shock level after fifteen periods. NW follow a more hump shaped development such that from period 3.5 onwards NW shows the highest UR with a peak in period six and 0.16% above pre-shock level after fifteen periods. BW reacts differently. A slight increase right after the shock is followed by a below shock UR with a minimum in period two. From period two onwards, it bounces back to reach and retain the pre-shock UR level for the entire simulation period.

DE reacts - as one would expect from an average- somewhere between the extremes of the Laender for TE, PR and UR. DE's and NW's reaction strongly resemble each other – not surprising as NW being the biggest Land has the strongest impact on the national average, DE.

Table 6-4: Reactions to a shock in Value Added in Services (VASER)

	TE reaction			PR reaction			UR reaction		
	SR*	MR**	LR***	SR	MR	LR	SR	MR	LR
Baden-Württemberg	+	+	°	+	°	°	-	□°	°
North Rhine-Westphalia	+++	++	°	+++	++	+	---	++	++
Schleswig-Holstein	+	□--	°	++	+	□°	-	□+++	+
Germany (West)	++	+	°	++	+	°	--	+	+

*SR = short run (period 0-3); **MR= medium run (period 4-8); ***LR=long run (period 9-15)

+++ value is very strongly above / ++ strongly above / + above pre shock level

° value is at pre shock level

--- value is very strongly below / -- strongly below / - below pre shock level

□ difference relative to the industry case

The reaction pattern to the value added shock in services (VASER) resembles that of value added shocks in industry with the following distinctive feature: The reaction in UR is slightly stronger for NW and DE, remarkably stronger for SH and less strong for BW. Especially in the medium run SH shows a stronger reaction than in the case of a value added shock in industry. Whereas the PR of SH remained above DE in the industry case after seven periods, it behaves like DE in the services case after eleven periods. The increase in UR for SH's services is more pronounced than in the industry case and highest of all units under study between period one and four. Looking at UR it can be concluded that a shock in VAIND impacts more

favourable on BW and SH, whereas for DE and NW a shock in VAIND and VASER does not differ much.

6.2.4. Labour cost and product price shocks

In this section, we model an increase of **real wages** by 1%. It reflects an increase in wages relative to product prices. The reaction pattern resembles the pattern of an increase in value added. The positive impact of an increase in real wages in industry on employment – in the short run- reflects the positive correlation of the SUR estimates with employment (see Chapter 5.2.2). The finding contradicts common neoclassical theory and the traditional Philips curve hypotheses.¹³⁷ The contradictory finding of an increase in employment resulting from an increase in wages is typical for empirical studies on German Laender, however. Based on panel VAR estimates, Möller (1995) also provides evidence that within Western Germany wage responses are weak and sometimes in the wrong direction.¹³⁸

Table 6-5: Reactions to a shock in Wages in Industry (WIND)

	TE reaction			PR reaction			UR reaction		
	SR*	MR**	LR***	SR	MR	LR	SR	MR	LR
Baden-Württemberg	+	+	°	+	°	°	-	-	°
North Rhine-Westphalia	+++	+	°	+++	++	++	--	++	++
Schleswig-Holstein	+	-	°	++	+	+	++	+	+
Germany (West)	++	+	°	++	+	+	-	+	+

*SR = short run (period 0-3); **MR= medium run (period 4-8); ***LR=long run (period 9-15)

+++ value is very strongly above / ++ strongly above / + above pre shock level

° value is at pre shock level

-- value is very strongly below / - strongly below / - below pre shock level

Observing an increase in wages in industry (WIND), employment effects are highest in NW leading to an increase of 1% relative to pre-shock level in the short-

¹³⁷ It suggests that the rate of change of wages relates to the deviation of the unemployment rate from its natural rate. If real wages increase, employment decreases and as a consequence unemployment increases above its natural rate.

¹³⁸ Kromphardt (1999, 16) criticizes the general assumption that wage restraint leads to more employment. He argues that the demand for labour is a derived factorial demand. He states: "The level [of labour demand] depends foremost on the level of the planned production." He suggests to consider that wages are not only a cost of production (neoclassical argument) but also the most important source of income which determines consumption (Keynesian argument).

run and even though declining steeply, remaining above those of the other Laender until period twelve. BW peaks after two periods at 0.1%, declines thereafter to reach pre-shock employment from period seven onwards. Right after the shock, SH's reaction is positive, after 1.5 periods until period seven it is negative, and from period seven onwards on pre-shock level. As in the case of the VA shock, only BW manages to reach pre-shock PR, after about six periods. PR of NW, SH and DE remains above pre-shock level: for NW about 0.15%, for SH and DE about 0.05% above. Again, this reaction shows the strong discouraged worker effect in NW, SH and DE. DE's reaction in employment lies – again - between that of the Laender.

UR first contracts for 1 to 2.5 periods before reaching and remaining above pre-shock level in SH, NW and DE. In BW, UR first declines for two periods before it remains at pre-shock level from period six onwards. Again, NW has highest troubles to reduce UR that after 15 periods remains 1.7% above its pre-shock level.

Table 6-6: Reactions to a shock in Wages in Services (WSER)

	TE reaction			PR reaction			UR reaction		
	SR*	MR**	LR***	SR	MR	LR	SR	MR	LR
Baden-Württemberg	°	+	°	+	°	°	+	°	°
North Rhine-Westphalia	+++	+	°	+++	++	++	--	++	++
Schleswig-Holstein	+	-	°	++	+	+	++	++	+
Germany (West)	++	+	°	++	+	+	-	+	+

*SR = short run (period 0-3); **MR= medium run (period 4-8); ***LR=long run (period 9-15)

+++ value is very strongly above / ++ strongly above / + above pre shock level

° value is at pre shock level

--- value is very strongly below / -- strongly below / - below pre shock level

□ difference relative to the industry case

The reaction to the real wages in services (WSER) shock follows that of the real WIND shock, especially in NW and DE. UR in SH and BW is slightly higher in the WSER shock than in the WIND shock.

6.2.5. Innovation (productivity) shocks

We model an innovation or productivity shock like Baussola (2007) who approximates such a shock by an increase in **labour hoarding** of 1%. The increase in labour hoarding reflects an increase in labour productivity stemming from a process innovation, for example. Blanchard (2006) provides the opposite causal chain how a reduction in productivity translates into a reduction in employment. When productivity is reduced, for example by workers labouring less concentrated because of a motivation lack, workers wage aspirations lead to stickiness of wages that reduces the demand for new employment. In addition, it decreases the profit rate of companies. As long as the profit rate of companies is below capital user cost, capital input decreases over time, which leads to a further decrease in employment.

Table 6-7: Reactions to a shock in productivity in industry (LHIND)

	TE reaction			PR reaction			UR reaction		
	SR*	MR**	LR***	SR	MR	LR	SR	MR	LR
Baden-Württemberg	+	+	°	+	+	°	°	-	°
North Rhine-Westphalia	+++	++	°	+++	+++	++	--	++	++
Schleswig-Holstein	-	-	-	+	+	°	++	++	+
Germany (West)	++	+	°	++	++	+	--	+	+

*SR = short run (period 0-3); **MR= medium run (period 4-8); ***LR=long run (period 9-15)

+++ value is very strongly above / ++ strongly above / + above pre shock level

° value is at pre shock level

--- value is very strongly below / -- strongly below / - below pre shock level

Analysing a 1% increase in productivity in industry (LHIND), we find a positive effect on employment in both short and medium run, in NW, BW and DE. In SH, TE is negatively affected over the entire sample period. DE and BW reach pre-shock employment levels after six periods, NW after eleven. The PR shows a pattern like in the case of the other shocks with peaks in period one and two and a decline thereafter. Besides the same pattern, the strength of the reaction differs. The reaction in PR in the medium run is more pronounced in BW, NW and DE. SH's PR reacts less pronounced in the short run. Also the UR reaction resembles the previous reactions with the exception of SH, which shows a UR marginally below that of DE after six periods.

Table 6-8: Reactions to a shock in productivity in services (LHSER)

	TE reaction			PR reaction			UR reaction		
	SR*	MR**	LR***	SR	MR	LR	SR	MR	LR
Baden-Württemberg	++	+	°	++	+	°	--	-	-
North Rhine-Westphalia	+++	++	°	+++	+++	++	--	++	++
Schleswig-Holstein	+	-	°	++	++	+	+	++	+
Germany (West)	++	+	°	++	++	+	--	+	+

*SR = short run (period 0-3); **MR= medium run (period 4-8); ***LR=long run (period 9-15)

+++ value is very strongly above / ++ strongly above / + above pre shock level

° value is at pre shock level

-- value is very strongly below / - strongly below / - below pre shock level

□ difference relative to the industry case

The overall reaction pattern in the case of a productivity shock in services (LHSER) looks similar to the effects in industry. BW and SH show a more intense reaction than in the industry case. In the short run, their reactions in PR and TE are more pronounced. This results in a lower UR. The UR of SH starts from a lower level in the LHSER shock than in the LHIND shock while reaching a peak at about 4% above pre-shock level in period three. In the long run the development of SH's UR remains above the national average in contrast to the LHIND case¹³⁹. BW shows the largest difference with its UR at a -2% pre-shock level after period one and remains below pre-shock level for the entire simulation period. As expected, DE performs between the extremes of the Laender.

6.2.6. Changes in economic policy variables: labour taxes, union coverage, active labour market policy

Again, shocks of labour tax (LTAX that include direct taxes on labour but also social insurance contributions), union coverage (UC which measures the number of employees covered by collective bargaining) and active labour market policy (ALMP which measures the percentage of active labour market policies – such as training of the unemployed – as a percentage of GDP) constitute the policy shocks. The nature of policy shocks differs from those examined shocks in a way that the policy maker can influence them more easily.

¹³⁹ This finding does not reflect in the table as the difference is marginal.

In the short and medium run, the reactions to the policy shocks are similar to the already considered shocks of value added, real wage and productivity. In the long run, however, a distinct difference for UC and ALMP can be found. This finding reflects the fact that policy shocks once induced initiate various feedback mechanisms whose consequences show after a certain time lag.

Table 6-9: Reactions to a shock in Labour Taxes (LTAX)

	TE reaction			PR reaction			UR reaction		
	SR*	MR**	LR***	SR	MR	LR	SR	MR	LR
Baden-Württemberg	+	+	°	+	+	°	+	-	°
North Rhine-Westphalia	+++	++	°	+++	+++	++	--	++	++
Schleswig-Holstein	-	-	°	++	+	°	+	++	+
Germany (West)	++	+	°	++	+	°	--	+	+

*SR = short run (period 0-3); **MR= medium run (period 4-8); ***LR=long run (period 9-15)

+++ value is very strongly above / ++ strongly above / + above pre shock level

° value is at pre shock level

-- value is very strongly below / - strongly below / - below pre shock level

As the policy variables are included in both labour demand in industry and services and both labour supply specifications in industry and services we observe their impact on labour demand and supply as a whole. This is extremely important when considering an increase of **labour taxes (LTAX)** by one percent. For the mechanisms explained in the model chapter, a labour tax shock has a positive impact on employment in the case of services and a negative impact in the industrial sector. We observe from the graph (see figure A-17) that in the short-run the positive effect on TE and PR prevails in NW so that UR is below the pre-shock level for the first two periods. In SH, the increase in TE only lasts for the first period, before a negative development in TE determines the total employment reaction to an increase in labour taxes. Consequently, UR is below its pre-shock level for the first period only, then rising to reach a peak after three periods and slightly declining thereafter. The reaction of the Laender to an increase in LTAX resembles most strongly the reaction to an increase in real WSER. Focussing on the reaction of UR to a LTAX shock, we observe an increase in UR in the short run for BW. In the medium and in the long run, UR increases in NW and DE. In SH, UR is increased over entire simulation period. UR of BW would be least affected by an increase in LTAX-

responding with higher levels of unemployment for two periods only and then fully absorbing the effects of the shock.¹⁴⁰

Table 6-10: Reactions to a shock in Union Coverage (UC)

	TE reaction			PR reaction			UR reaction		
	SR*	MR**	LR***	SR	MR	LR	SR	MR	LR
Baden-Württemberg	+	+	°	+	+	°	°	-	°
North Rhine-Westphalia	+++	+	-	+++	++	°	--	++	++
Schleswig-Holstein	-	--	-	++	+	-	+	++	+
Germany (West)	++	+	-	++	+	°	--	+	+

*SR = short run (period 0-3); **MR= medium run (period 4-8); ***LR=long run (period 9-15)

+++ value is very strongly above / ++ strongly above / + above pre shock level

° value is at pre shock level

-- value is very strongly below / - strongly below / - below pre shock level

The TE reaction to an increase in **union coverage (UC)** differs from the previous reactions in the medium and long run. So far, reactions from NW and DE converged to zero after eight to twelve periods. In a response to an increase in UC, however, they continue declining so that they reach a negative value of TE at the end of the simulation period of -0.02% for NW and -0.01% for DE. Kaas & von Thadden (2003, 475) confirm this finding: “[...] attempts by unions to raise wages [the variable UC measures bargaining coverage which often translates into higher wages] are likely to trigger an investment slow-down in order to restore the initial level of profitability, and, as a by-product, the adverse impact effect on employment may be further exacerbated.” Employment in SH follows the behaviour as previously stated, but remains below pre-shock level until period fifteen at -0.015%. Following a small peak in period three, BW reaches and retains pre-shock levels after about eight periods. Whereas in the case of the other shocks in the long run TE of the Laender and the national average converged, differences solidify in the range of 0% change in BW and – 0.02% for NW.

¹⁴⁰ Harrigan *et al.* (1996, 128) apply a computable general equilibrium model to Scotland to analyse the impact of an automatic labour subsidy in the regional economy. They observe: “[...] that a general, automatic labour subsidy would increase employment and activity within the recipient region, but care needs to be taken concerning the overall desirability of such a subsidy, given that the impact on non-recipient regions has not been considered.” In Germany, such a regional subsidy also exists the “Solidaritätszuschlag”. It was originally introduced to finance the cost of German unification and is transferred from the Western to the Eastern Laender. The subsidy increases the tax wedge and it can be simulated by the LTAX variable.

In PR, the reaction to increases in UC also differs. From the medium run onwards, NW and SH continue declining and reach a smaller than pre-shock PR. By the end of the period SH shows the largest drop in PR by -0.15%, followed by NW (-0.08%).¹⁴¹

The solidified divergence in TE and the ongoing decline in PR lead to a similar impact on UR as in the cases of the other shocks. Until period four SH shows the worst development of UR with an overall peak at 4% in period three and declining thereafter. NW and DE follow again a hump-shaped curve, with NW experiencing the larger radius and the worst development of the UR from period four until the end of the simulation period. BW shows the most favourable UR development with lower UR between period two to eight and pre-shock UR thereafter. An increase in UC hits the employment levels stronger than other shocks. This applies to NW and to a smaller extent to SH. At the end of the simulation period NW and SH find themselves at lower levels of economic activity expressed in lower PR and lower TE. In addition, DE is negatively affected. Only BW manages to keep its level of economic activity and absorbs the shock after about six to eight periods.¹⁴²

Table 6-11: Reactions to a shock in Active Labour Market Policy (ALMP)

	TE reaction			PR reaction			UR reaction		
	SR*	MR**	LR***	SR	MR	LR	SR	MR	LR
Baden-Württemberg	+	+	°	+	+	+	++	+	+
North Rhine-Westphalia	+++	+	°	+++	++	+	--	++	+
Schleswig-Holstein	°	-	°	+	-	---	+	-	--
Germany (West)	++	+	°	++	+	°	--	+	-

*SR = short run (period 0-3); **MR= medium run (period 4-8); ***LR=long run (period 9-15)

+++ value is very strongly above / ++ strongly above / + above pre shock level

° value is at pre shock level

--- value is very strongly below / -- strongly below / - below pre shock level

The shock of **active labour market policy (ALMP)** provides the most distinct reaction of the Laender. In TE, all Laender and DE follow a development similar to the LTAX shock especially in the long run. The reaction to the ALMP shock is less

¹⁴¹ Remember that the signs in the tables always display the average of the entire periods in the short, medium or long run. In this case a negative value at the end of the period for NW only leads to a “pre shock” sign as it cancels out with previous positive periods in the long run.

¹⁴² In a study on labour market institutions and macroeconomic volatility in OECD countries Rumlér & Scharler (2008) find that coordinated wage-bargaining systems might act as shock absorbers.

favourable for the PR in NW and SH than in the LTAX shock! In the short run all Laender show their peaks and declining development, as often observed. This also holds for DE. After four to five periods, however, it becomes evident that BW keeps its PR above pre shock levels right until the end of the simulation period so that DE's PR is below BW's from period seven onwards. In NW, PR continues declining and reaches a value below the BW level in period twelve. The most drastic response shows SH whose PR declines continuously until it reaches -0.5% at the end of the simulation period. Therefore, ALMP reduces dramatically labour supply in SH and slightly less so in NW!

The development on the labour supply side dominates the UR response. From period, four onwards SH shows the lowest UR, until it converges to a value that is 4.3% lower than its pre-shock level. DE shows – after period five – the second best development so that its UR declines to reach a value at 0.8% below pre-shock level. Even NW manages to perform better – in the long run - than BW occupying a value of 0.2% above pre-shock level. BW shows the worst development in the long run with UR increasing to about 1.1% above pre-shock level. The example shows that ALMP reduces UR in DE and SH at the cost of a lower PR not by creating higher employment levels. The mixed response for SH, NW, DE and BW confirms Martin (2000): "At first sight, the bottom line from recent OECD research on the effectiveness of active labour market policies is not terribly encouraging. The track record of many active measures is mixed in terms of raising the future employment and earnings prospects of job seekers and producing benefits to society."

6.3. Policy implications of the Laender's reaction patterns to shocks on the labour market

In the last sections, we examined regional reactions focussing on the different shocks. The focus was on all the Laender's and DE's reaction to a specific shock. In this section, we aim at providing a short description of the characteristic reactions of each Land and DE. We start with the most innovative region BW, followed by NW, and SH. A description of DE complements this section.

Baden-Württemberg (BW) shows after phase one with the modest increase in TE and the decline thereafter until period six, a phase three that is characterised by phasing out on the pre-shock level. BW shows the second smallest increase in TE,

except for the UC shock where it manages to keep pre-shock levels in contrast to NW and SH.

The development of PR in (BW) shows a similar pattern than that of NW and DE even though less pronounced. The difference constitutes out of the maximum value that is reached after two periods and the pre-shock level, which BW reaches after six periods already.

The PR reaction shows the weakest response indicating the lowest discouraged worker effect of SH, NW and BW. Again, after a modest peak in period two and a decline thereafter, PR reaches pre-shock level after six to seven periods. It occupies the lowest values in PR change except for the UC and ALMP shock, where it manages to remain at pre-shock level in contrast to NW, SH.

BW shows the strongest reaction in UR for the first period after the shock but then UR declines until it reaches its minimum value after two to three periods. After two to three periods BW's UR remains at the lowest level of SH, NW and BW. An exception to the rule is once again the reaction to the ALMP shock where BW's UR is highest after eleven periods of all Laender and DE, as its PR does not decrease like in the case of SH, NW and DE.

In total, **BW** as the most innovative region reacts in the most robust manner against all shocks. It shows the least variation and pre-shock levels are – not only in TE but also in PR and UR - reached after about six periods. Its biggest advantage comprises that after one period UR is at or below pre-shock levels. This means that BW quickly absorbs shocks. It could gain most from a productivity increase in services. BW's biggest disadvantage constitutes the low reaction in TE also to advantageous effects.

North Rhine-Westphalia (NW) shows the highest reaction of all Laender to most of the simulated shocks.

The reaction of TE is strongest right after the shock and then declines sharply before it reaches pre-shock level after period eight to ten. After the strong decline in phase one, in phase two from period eight onwards it remains at pre-shock level.

The strong reaction of PR signals a high-discouraged worker effect. The first of the two phases lasts for one period until PR reaches its peak. After the peak, PR

declines sharply and after period four to six more slowly. At the end of fifteen periods PR still remains above pre-shock level.

The reaction of UR is worst of all Laender after about four periods. Right after the shock the UR level is below pre-shock level, afterwards, it is steeply increasing however, before it reaches the maximum after six periods. In the remaining nine periods it decreases very slowly so that after 15 periods it still stands 1.5% above pre-shock level.

Macroeconomic shocks highly affect **NW** in the short, but also in the medium and long run. It manages to reach pre-shock level only in TE after about ten to twelve periods. The strong increase in TE as a reaction to positive shocks in the short run, is a positive starting point for the development of NW. The most negative feature of NW characterizes the instantaneous drop of TE right after the initial increase paired with a decline in PR so that UR remains at very high levels in the medium and long run. A decreasing PR following an increase in active labour market policy constitutes a further negative point. In total, NW seems to have great difficulties to cope with shocks – even in the long run. This might reflect its dependence on traditional industries.

The general TE reaction to all shocks in **Schleswig-Holstein (SH)** can be split up into three phases. The first phase – right after the shock - starts with a positive impact on UR.

SH's TE decreases immediately to reach its minimum value at the end of phase one- after three periods. From period three until period eight TE increases until it reaches the pre-shock level that marks the end of phase two. In phase three TE remains at the pre-shock level and the impact of the shock on TE fades out. The decrease in TE and following bouncing back is unique among the Laender under study. PR consists of only two phases and the reaction of SH is after BW the second weakest. The first phase reaches the maximum value and ends after one period.

From then on, PR declines in a fluctuating pattern in the second phase and behaves after about eight periods like DE. PR remains above the pre-shock level also after fifteen periods. The response to the LHIND shock constitutes the exception when the PR of SH declines more strongly and reaches pre-shock level after fifteen

periods. Further exceptions are the reaction to UC and ALMP shocks where the PR deteriorates to levels below pre-shock.

The UR reaction consists out of two main phases. Starting at a UR below pre-shock it rises instantaneously and peaks at the beginning of period three. After the peak phase two initiates and UR declines steadily remains however, above pre-shock level after fifteen periods. In period two to four SH has the highest UR of all Laender. From period five onwards it develops like the German mean. In industry, it shows a lower UR than DE, in services it shows a higher UR than DE, which reflects its recent competitiveness in some industry sectors. ALMP is again the exception where UR of SH declines to -4.5% of pre-shock level after 15 periods.

SH shows a strong reaction to shocks in the short run and is relatively robust against shocks in the medium and long run. Overall, it shows the second weakest reaction to shocks and it reaches pre-shock level in TE mostly after eight periods. The unfavourable, negative reaction of TE on positive shocks in the short and medium run up to period five constitutes a big weakness. A further big weakness is the reduction in labour supply by active labour market policies! Its biggest strength characterises the ability of gradually absorbing the initial shocks so that UR reduces after a peak in period five. This may be a consequence of its bigger SME base relative to a dominance of big companies in NW, for example.

Looking at the shape of reactions to shocks, **Germany (DE)** shows a similar development as NW – the biggest Land in Germany. The development is more favourable to that of NW, however. The development of TE is more favourable than that of NW. The more important part in determining Ur plays the PR, however.

For the PR it shows the second strongest reaction after NW, with a peak right after the shock and then declining. DE manages to reach pre-shock level after 6-8 periods with the exception of UC where TE becomes negative after five periods. The maximum value is reached after two to three periods and PR declines thereafter to reach a value 0.5% above pre-shock level. The reaction to the UC and ALMP shock is the exception so that PR falls below pre-shock level.

The UR behaves similarly to that of NW, starting low and reaching a peak above pre-shock level after six periods. In the remainder of the simulation period, it declines slowly and remains 0.5% above pre-shock level. The reaction to the ALMP

shock is an exception, where the UR of DE reaches values below the pre-shock level and retains them after ten periods.

To summarise, macroeconomic shocks affect **DE**, which manages to reach pre-shock level only for TE, after eight periods. The biggest strength of DE makes up the only moderate increase in UR and the decline after its peak in period five, especially in services. Like NW, it does not manage to keep employment levels up and shows an inability to absorb shocks although less pronounced than NW.

Conclusions and Policy Recommendations

The thesis **aims** to contribute to research on regional labour market modelling while also providing a tool for the policy decision maker in Germany, its federal states, and Europe.

We outlined a **need** for convenient models able to capture labour market dynamics on a sub-national level, considering the institutional framework and the phenomenon of innovation. The complex framework called for special consideration of how the same national or international macroeconomic policy or economic shock affects a sub-national level.

A **brief summary** of the findings: Based on the example of three characteristic Western German Laender (Federal States) we applied an appropriate macro econometric model that allowed us to analyse the labour market of those states and Germany.

We simulated three economic shocks in industry and three in services, namely an increase in value added, in real wages and in innovation (productivity). We also modelled three policy shocks: an increase in labour taxes, in union coverage and in spending on active labour market policies. Reactions of the three German NUTS 1 Laender to the shocks were different: Baden-Württemberg (BW) as the most innovative of the Laender reacts most robustly on the simulated shocks. It reaches its pre-shock levels of labour demand, labour supply and the unemployment rate after about six periods and shows a generally favourable development in its unemployment rate. West Germany (DE), North Rhine-Westphalia (NW) and Schleswig-Holstein (SH), with lower levels of innovation, have more problems to absorb shocks. This holds especially for NW whose unemployment rate after 15 periods remains above pre-shock levels for all shocks. Besides the confirmation of distinct reaction patterns, we find that labour demand dominates the short run response and labour supply variables the medium and long run response. This indicates that the hysteresis effect on the labour demand side decays faster and thus, labour supply determines the development of the unemployment rate after the first few periods.¹⁴³ Other studies confirm the finding of the pivotal role of the supply side also for entire regional economies: "The basic rationale underlying the approach adopted

¹⁴³ In the short run and with sticky prices, demand can be influenced by monetary, fiscal policy and various other factors. Hence, these demand stimulating policies may be useful in stabilizing the economy in the short run (see Mankiw, 2003, 241).

by the Study Group is that regional disparities are in the nature of a long-term type of problem, and not the result of short-term cyclical fluctuations. As a consequence, the emphasis both of analysis and of policy actions must be on the supply or capacity side and not on the demand side of a regional economy. (CEC, 1985, 62)” The analysis also reveals development tendencies in distinct regional economies such as effort in innovation, or developments in economic structure. Altogether, it shows the diverse impact of the same macro policy on the development of labour demand, labour supply and their matching within the Laender.

The **thesis in more detail**: After an introduction, we reviewed macroeconomic modelling in the past as basis for our labour market analysis. We briefly touched upon the tendency in the geographical focus of such models. We identified four major approaches in macroeconomic modelling: the large-scale macroeconomic models, dynamic stochastic general equilibrium (DSGE) models, unrestricted vector autoregressive (VAR) models and structural cointegration VAR models. The next sections then provided worldwide applications of these types of models. Moreover, the last section of Chapter 1 dealt with applications in a German context.

Chapter 2 provided the theoretical background for our labour market model by introducing the reader to basic employment and unemployment theory and the role of innovation. We extensively utilized the NAIRU model (Franz, 2006) to explain mechanisms of unemployment. Extensions of the NAIRU model allowed for discussing reasons that lead to persistent unemployment.

The conventional NAIRU model falls short in incorporating the innovation phenomenon, however. Another criticism of the NAIRU model points at the non-inclusion of expectations within the model specification. It is often argued that expectations about the economic development in the next periods determine labour demand in the current period. In addition, the NAIRU model does not sufficiently reflect the underlying structural mismatch of heterogeneous labour demand and supply. The heterogeneity can stem from differences in qualification, geographical occurrence or information deficit.

Following the major shortcoming of the NAIRU in not considering innovation, we dedicated the second part of Chapter 2 to the theory of innovation and technological progress. We also discussed the question about the effects of creative destruction (Schumpeter, 1942) and found empirical evidence that innovation relates positively to employment at a national level. We also found a positive relation at a sub-national level when we looked at data of BW, NW, SH and DE. BW as the most

innovative Land showed highest employment and lowest unemployment rates. The descriptive analysis further revealed that BW's higher wealth mainly stems from its effort in innovation, which translates into high labour productivity. The general finding of higher labour productivity had to be reformulated as it was found to hold for the industry sector only! Further findings were the struggle of NW with its traditional sectoral structure, whereas SH increased its competitiveness in innovative industries in the recent past. We further observed divergence in wealth between BW and the other two Laender. The momentum of divergence decreased after 1991, however. BW tends to converge to DE whereas the weaker Laender, NW and SH, lose momentum and diverge away from DE!

Having developed a solid understanding of the economic context, we built a **dataset** for analysing the labour market. 30 yearly observations seemed to be appropriate as basis for our model. Dealing with innovation data raised the question of the appropriate geographic unit of analysis. Referring to the intense decay in spatial effects in general (Niebuhr, 2003) and particularly in spill over effects from innovation after about 100 kilometres (Boltazzi & Peri, 2000), we decided to collect data on a NUTS 1 level. The NUTS 1 level also minimised the issue of commuting which is relevant in any lower geographical level. In Germany, the NUTS 1 level coincides with the Federal States structure. We restricted the analysis to Western German Laender because of data constraints for Eastern German Laender before 1990.

While collecting data we had to merge data from five major sources: regional and national accounts data RA (2007) & SBA (2000 & 2008), annual household survey data MIK (2008), Research Institute of Occupation and Labour Market data IAB (2008), Regional Statistical Office data SLA (2008) and Centre for Economic Performance data NIC (2006). Science data was collected from the Foundation for German Science, Grenzmann & Kladobra (2006).

Referring to these sources we harmonised data in order to compose a data set for Western German Laender with annual data ranging from 1975 until 2005. We segregated data for the industry and services sector into two sub-categories according to their level of innovation and knowledge intensity. The resulting dataset provided a solid basis for the labour market model.

Because of different sources and in some cases different definitions the dataset – like any other dataset- still contains some fuzziness. Further criticism include additional assumptions which had to be made in a few cases, such as interpolating

trends for some missing years of specific variables in order to reach a composite, usable dataset.

For the resulting labour market model based on the descriptive analysis and on the data set, a modelling strategy and philosophy had to be chosen as the general “rule” for the model’s structure. After having reviewed modelling strategies and philosophies, we chose the specification of Baussola (2007) as starting point. The choice was motivated by the requirement of an easy to manage specification that allows tracing back effects of shocks on central relationships.

We extended his specification to incorporate aspects of innovation and institutional setting and applied it to a multi-regional framework. The resulting model was then applied to Germany but could - due to our extensions - also be applied in an international and increasingly innovation driven framework!

Again, as stated in the outline, the model comprises a labour demand, a labour supply block and incorporates institutional variables making it suitable also for an international context. Four equations constitute the labour demand block, two for demand in industry, and two for demand in services. Two equations constitute labour supply: one for the participation rate and one for self employment. The specification follows a dynamic error correction representation that allows for short run and long run dynamics. Five identities close the model.

The model specification does not include the goods market explicitly, which would be desirable for an analysis of trading interactions between regions. Another critical remark stems from the specification that does not differentiate between different types of labour supply, geographical preferences and the information set of agents. Other factors determining the matching such as housing prices as a major determinant of commuting or migration are also not considered in the model specification. Most of the shortcomings are typical for classical macroeconomic models.

Next, after the model specification we dealt with model estimation. In choosing the appropriate estimation method in a panel of four geographical units and thirty periods in time we applied the ordinary least squares (OLS) as well as the seemingly unrelated regression (SUR) estimation method. We chose OLS as standard estimation method. We complemented it by the SUR approach as it proved to fit the data well in a χ^2 test. Barbieri (2007) who tested five estimation methods in a similar framework to ours further recommended it. Irrespective of the estimation

method, over fifty variables from eighty possible variables were significant on the labour demand side. Labour demand depends most clearly on value added and for services also on labour hoarding in BW and SH. The better structural fit of the SUR methodology opposed to OLS can be further observed by fifty-four opposed to only thirty-six significant variables in the OLS case. In the shock exercise, the dominant role of the labour supply side underlines the importance of a good fit of the estimation method and the model structure. Besides the large number of significant variables, only the three utilized – labour tax, union coverage, and active labour market policy - out of the nine proposed policy variables by Nickel (2007) were significant.

This imposes the question of how far they are able to entirely capture the institutional framework. The shortcoming of availability of innovation data before 1990 did not allow disaggregating labour demand in industry and services according to their level of innovation and knowledge intensity in the empirical part. In addition, the timeframe of thirty years with thirty observations did not always lead to clear cut answers, for example in tests for autocorrelation.

The dynamic deterministic simulation of the model revealed a good fit for both the OLS and the SUR approach. The lower values of Theil's inequality coefficient (TIC) and the root mean square error (RMSE) showed a slightly better fit of the OLS approach to reproduce endogenous variables. The Mincer-Zarnowitz test revealed one case of too confident and three cases of too timid estimations, two each for OLS and SUR.

Looking at the results more closely we found the better fit of TIC and RMSE being mainly based on a higher dependence of the endogenous variables on their lagged values. The structural argument, the visual inspection of the OLS residuals and the previously cited χ^2 test favoured the use of the SUR methodology for the shock exercise. The theoretical introductory note, which assumed high initial reactions right after the shock and slow adjustments, was found to be true for all the Laender and West Germany.

We first simulated value added shocks in industry and services. The reactions of both shocks were relatively similar and reflected the sectoral structure of the Laender and DE. The strong reaction for BW in the case of a value added in industry shock coincides with its stronger dependence on the industry sector. The reaction of the unemployment rate revealed that BW and SH react more advantageously to a shock in value added in industry than DE and NW. The reactions of NW's and DE's

unemployment rate in response to a shock in value added in services resembled that of a shock in value added in industry.

The reaction of all Laender and DE to an increase in real wages was similar to that of the value added shock in the long run. Again, reactions to a shock in real wages in industry did not differ much from reactions to real wages in services. As in other cases, the reaction in BW was least intense. The exception was SH which showed a slightly higher sensitivity to an increase in real wages in services than in industry indicating its higher competitiveness in the industry sector!

The reactions to an innovation (productivity) shock in services were more distinct than in industry for SH and BW. Whereas in the short run both Laender could considerably decrease their unemployment rate, SH's unemployment rate increased in the medium run more pronounced compared to the industry case. In the long run SH did not manage to decrease its unemployment rate below DE's value opposed to the industry case. Again, besides the considerable hysteresis effect on the labour supply side, this reflects the weaker competitive position of SH's services sector. An innovation shock in BW led – on the contrary - to a more favourable development of its UR opposed to the industry case. Having a very competitive industry sector, employment in BW would gain more from an increase in productivity in its services sector!

The last shocks investigated were the policy shocks of labour tax, union coverage and active labour market policy. In the short and medium run, policy shocks lead to similar reactions, whereas in the long run reactions to a shock in union coverage and active labour market policy differ.

The unemployment rate reaction of a shock in labour taxes was similar to the previous shocks. In the short run, SH performed worst in the unemployment rate. In the medium run, it managed to decrease its unemployment rate relatively to NW and DE. NW and DE were hit strongest by an increase in labour taxes. BW managed to absorb an increase in labour taxes from period three onwards so that its unemployment rate remained at pre-shock levels from period three onwards.

The difference of an increase in union coverage opposed to other shocks, results in consistently lower employment levels – even after fifteen periods - for SH, NW and DE.

Besides the consistent decrease in employment demand, also labour supply decreased so that an increase in union coverage permanently lowers the level of economic activity except in BW from period seven onwards.

We observed the most distinct reactions to a shock in active labour market policy. The labour demand side followed a converging pattern as in the case of most other shocks. The labour supply side, however, reacted differently: In SH, NW and DE the participation rate continued decreasing over the entire sample period. Together with the converging labour supply side, this resulted in a substantial decrease in the unemployment rate for SH, a decrease in unemployment rate for DE and a pre-shock unemployment rate after fifteen periods for NW.

For a shock in active labour market policy, the cost of a decrease in the unemployment rate consisted of a substantial fall in the participation rate which led - like in the case of a labour tax shock - to a decrease in economic activity. For the first time, BW did not manage to restore pre-shock unemployment rate, so that its unemployment rate stood at 1% above pre-shock level in period fifteen. The increase in the unemployment rate resulted from a persistent increase of its participation rate – in sharp contrast to the other Laender and DE!

Remarks: modelling an increase of each shock of 1% is arbitrary; it could be desirable to model increases and decreases in variables that are more pronounced for confronting the results. The once-at-a-time shock simulation does not allow for interaction between shocks and simultaneous policy reforms. Modelling simultaneous shocks would - with the feedback mechanisms inherent within the current model - impose difficulties in the interpretation of the reactions to the shocks.

The **interpretation** of the **estimation results** suggests that in BW and SH the industry sector still shows comparably high employment multipliers like the services sector. German and regional policies intended to foster industry are thus especially fruitful in these Laender. In NW by contrast, high employment multipliers stem from the services sector only and DE shows higher employment multipliers in the services opposed to the industry sector. The shock exercise has shown that labour demand depends more positively on value added than negatively on real wages in all Laender and DE. Pesaran *et al.* (1994) state: "Much applied research has focused on the responsiveness of labour demand to changes in real wages and in output levels in an effort to evaluate the efficacy of different policies designed to reduce unemployment." This suggests that policies facilitating an increase in value added increase labour demand. The resulting decrease in the unemployment rate is short lived, however, as the reaction to the shock shows. In NW, SH and DE, the unemployment rate only remains for about two to three periods below its pre-shock level. Only in BW such a policy leads to a reduction in the unemployment rate also in the medium run. The immediate reaction on the

labour demand side and the lagged reaction on the labour supply side is a characteristic for all shocks.

The evaluation of the efficacy of a labour market policy thus only makes sense at least four or five years after the shock and should also comprise the labour supply side.

In general, the **policy maker** should act with caution as the same policy leads to different outcomes in the Laender and DE as a whole. As a rule of thumb, reactions in highly innovative Laender are less pronounced and shocks are quicker and more completely absorbed than in less innovative Laender. The major problem comprises the discouragement effect in NW, SH and DE as well as the extremely conducive impact of active labour market policies of their current type in NW, SH and DE.

Looking at the **significance of the thesis**, we found that the use of NUTS 1 level data adequately informs us about labour market reaction patterns of Western German Laender. Analysing the reactions to shocks enables regional as well as national and supra-national policy makers to gain important insights on how different the same policy measures affects a sub-national level. The thesis proposes answers to the claim of Sant (1987, 38): “The art of formulating regional policies lies in understanding the nature and causes of disparities and in being able to predict the impact which will follow their implementation.” The current work contributes to quantifying the impact of such policies. The contribution of the thesis is especially relevant in an increasingly competitive economy in which regions become the centre of economic progress and political interest. Regional aspects, sectoral analyses, as well as the domain of innovation will experience greater significance in future labour market modelling.

For **further research**, an increase in the time span or the frequency of the data set would be desirable. Especially data on the institutional setting and data on innovation calls for improvement. The labour tax variable does not differentiate between taxes in services and taxes in industry and composes social insurance contributions, for example. All policy variables are defined on a national level, whereas a sub-national level would be desirable. Data on Eastern Germany would allow for a comparison between Eastern and Western German Laender. A methodological advancement but not possible yet, could be to increase the number of explanatory variables in order to widen the scope of the model and its relationships to the complexity of the real world. Promising variables comprise a business cycle measure of the world together with the introduction of export and import rates in order to capture increased national and international trade and

interrelations between regions. Structural variables on the labour demand side could comprise a measure of the firm size, or of the firm size distribution in the respective sector, such as the Herfindahl (see Hirschmann, 1964) coefficient to capture the degree of competition within the economy's sub-sectors. On the supply side, a measure of educational attainment or human capital could be useful. Another approach in this area could be a subdivision of the participation rate estimation into a participation rate for labour endowed with high human capital and a participation rate for labour endowed with lower human capital. This would be a further step towards a more profound recognition of the importance of education also in the light of the innovation phenomenon.

Appendix: Data

A.1 Details on data sources and variables

Table A-1: Details on data sources and variables

Notes:	
NIC (2006)	The CEP – OECD Institutions Data Set (1960-2004) William Nickell, Centre for Economic Performance, LSE, September, 2006
RA (2007)	Regional Accounts dataset (Volkswirtschaftliche Gesamtrechnung der Länder, VGRdL) reconciled out of the following: - Rückrechnung 1970-1991, Statistisches Landesamt Baden-Württemberg, Stuttgart, 2007 - Bruttoinlandsprodukt, Bruttowertschöpfung in den Ländern und Ost-West-Großraumregionen Deutschlands 1991 bis 2006 Vorabversion zu Reihe 1, Band 1, Statistisches Landesamt Baden-Württemberg, Stuttgart, 2008 - Arbeitnehmerentgelt, Bruttolöhne und -gehälter in den Ländern und Ost-West-Großraumregionen Deutschlands 1991 bis 2006 Vorabversion zu Reihe 1, Band 2, Statistisches Landesamt Baden-Württemberg, Stuttgart, 2008 - Bruttoanlageinvestitionen in den Ländern und Ost-West-Großraumregionen Deutschlands 1991 bis 2005 Reihe 1, Band 3, Statistisches Landesamt Baden-Württemberg, Stuttgart, 2008 - Entstehung, Verteilung und Verwendung des Bruttoinlandsprodukts in den Ländern und Ost-West-Großraumregionen Deutschlands 1991 bis 2006, Statistisches Landesamt Baden-Württemberg, Stuttgart, 2007
SLA(2008)	Exclusively calculated and provided by the Statistisches Landesamt Baden-Württemberg based on regional accounts data, Stuttgart 2008
SBA(2008)	Provided by the National Statistical Office, Wiesbaden, 2008: Gesamtwanderungen nach Bundesländern, Statistisches Bundesamt, VI A, Wanderungsstatistik, Wiesbaden, 2008
MIK(2008)	Continuous household survey (Mikrozensus). It is the official representative statistics of the population and the labour market, involving 1% of all households in Germany every year provided and is provided by the National Statistical Office: Bevölkerung nach Beteiligung am Erwerbsleben und Ländern, Ergebnisse des Mikrozensus, Wiesbaden, 2008
IAB(2008)	Data is exclusively provided by the Research Institute of Occupation and Labour Market (IAB Nürnberg) and contains the following: - Working hours in six sectors from 1991-2007 (IAB-Arbeitsstunden A6_91_07), Institut für Arbeitsmarkt- und Berufsforschung (IAB) der Bundesagentur für Arbeit (BA), Nürnberg. - Working volume from 1970-1991 (AVR 70-91rev), Berechnungen des IAB (FB 4) - Employees from 1970-1991 (AVR 70rev), Berechnungen des IAB - Components of Working time from 1991-2007 (AZ Komponenten), Berechnungen des IAB
SBA (2000)	Data is obtained from the National Statistical Office (from various Statistical Yearbooks) out of the following: - Statistisches Bundesamt (1994): Statistisches Jahrbuch 1994 für die Bundesrepublik und das Ausland, Wiesbaden - Statistisches Bundesamt (1995): Statistisches Jahrbuch 1995 für die Bundesrepublik und das Ausland, Wiesbaden - Statistisches Bundesamt (2000): Statistisches Jahrbuch 2000 für die Bundesrepublik und das Ausland, CD-Rom, Wiesbaden

Notes on Variables	
ALMP	The measure for active labour market policy is available from 1985 until 2003 for West Germany. Values from 1975-1984 and 2004 and 2005 have been proxied by applying a moving average to the last two available years of the data. This procedure is adopted because most of the policy variables are available until 2003 only. In 2002 in Germany the national election brought about a political change and it is assumed that this policy change in 2002 impacts on the 2002, 2003 and following values. In addition, we are more interested in the most recent values as they make part of the shock exercise and hence adopt this procedure preferring to consider the most recent development at the expense of the historic development (here from 1975-1984).
CO	The measure for coordination of wage-bargaining is available from 1975 until 2000 for West Germany. Values from 2001-2005 have been proxied by applying a moving average to the last two available years of the data. The coordination index is not included in the analysis as it takes the value of "4" throughout the entire data period for Western Germany.
DEFIND DEFSER	Calculation of deflator based on VA of last year multiplied by price-adjusted % change of the current year to receive VA of the current year with prices of last year. The deflator is then the VA of the current year in current prices divided by the calculated VA in prices of last year. Hence the deflator is on a year-to-year basis. The German revision of "VGR" in 2005 follows the European guideline of 1998 in calculating the deflator on the previous year and not on a reference year.
DEFIND(H,L) DEFSER(H,L)	For Western German regions not available, hence DEFIND and DEFSER are taken.
EP	The measure for employment protection is available from 1975 until 2003 for West Germany. Values for 2004 and 2005 have been proxied by applying a moving average to the last two available years of the data.
LF	The number of unemployed is obtained by reconciling data of the employment rate as a fraction of total labour force from the continuous household survey (Mikrozensus, MIK (2008)). In addition employment data is used from regional accounts (RA (2007)). The labour force is obtained by adding the number of the unemployed (the fraction of employed to unemployed is taken from MIK 2008) to the number of the employed (which is taken from RA 2007). It has to be noted that the labour force values are only proxies as MIK (2008) and RA (2007) have different definitions of unemployment as noted in the chapter about the data.
LHIND LHSER	Data is available from 1998 until 2005. The missing data is obtained as follows: Average working hours data of dependend employees from 1975 until 2005 is aggregated (NUTS 0 level). This is done by multiplying the number of workers in the respective subsector (6 in total) times the average working hours in this subsector to get the volume of work. Aggregate the values of the six subsectors correspondingly to get total volume per three subsectors (agriculture, industry, services). Divide the respective working volume by number of heads of the respective sector to get the average hours worked by sector per worker for West Germany (NUTS 0 level). From the regional accounts data calculate average hours worked by volume and divide by heads of dependend employees in 3 sectors on NUTS 1 level for 1998-2005. Calculate the sum of all average hours worked of Western German regions (Länder) from 1998-2005 to get simple mean. Confront this simple mean to values obtained from West Germany. Calculate the average discrepancy between these two means (note that in the IAB data West Berlin is included and values are based on "Inlandskonzept" whereas the data from the regional accounts is without West Berlin and based on the "Inländerkonzept"). To correct for these differences, deduct the average discrepancy from the West German data from 1970-1997. Values from 1975-97 are estimated by applying a moving average for 7 periods (max. time span available) for the regions. Finally, adjust the regional values to incorporate the Western German trend: Multiply each regional MA value by (simple mean of regional values / (adjusted) national value).
PR	The participation rate is obtained by dividing TE and LF.
PROF	Data on profits is available from 1980-2005. The values for 1975 until 1979 are obtained by the following procedure: Approximate primary income of households by national income (receipts from business activity and property income) for West Germany (from national accounting). Calculate the wage share by dividing primary income of households through national income for the years 1975-1980 for West Germany (from national accounting). Take the change rates of the wage share for the years 1975 to 1980 and apply them to the values from regional accounting to get the corresponding values for the years 1975-1979 West Germany, based on the regional accounting methodology. Estimate values from 1975-1979 for the Western German regions by applying the moving average procedure (7 periods, as in the case of LH). Sum the yearly values of all regions and compare to the calculated West German values. Adjust the regional values to capture the trend of the national development. Obtain the wage share of Western German regions from 1975-2005. Divide the available values for compensation of employees by the calculated wage share to obtain the primary income of households. Finally, obtain the profits by subtracting the compensation of employees from the primary income of households for the Western German regions.
SE	The number of the self-employed are calculated by subtracting E from TE.
VAIND(H,L) VASER(H,L)	Data only available from 1995 until 2005.
WIND(H,L) WSER(H,L)	Data only available from 1995 until 2005.

A.2 Classification of NACE

Table A-2: Classification of NACE, rev. 1.1

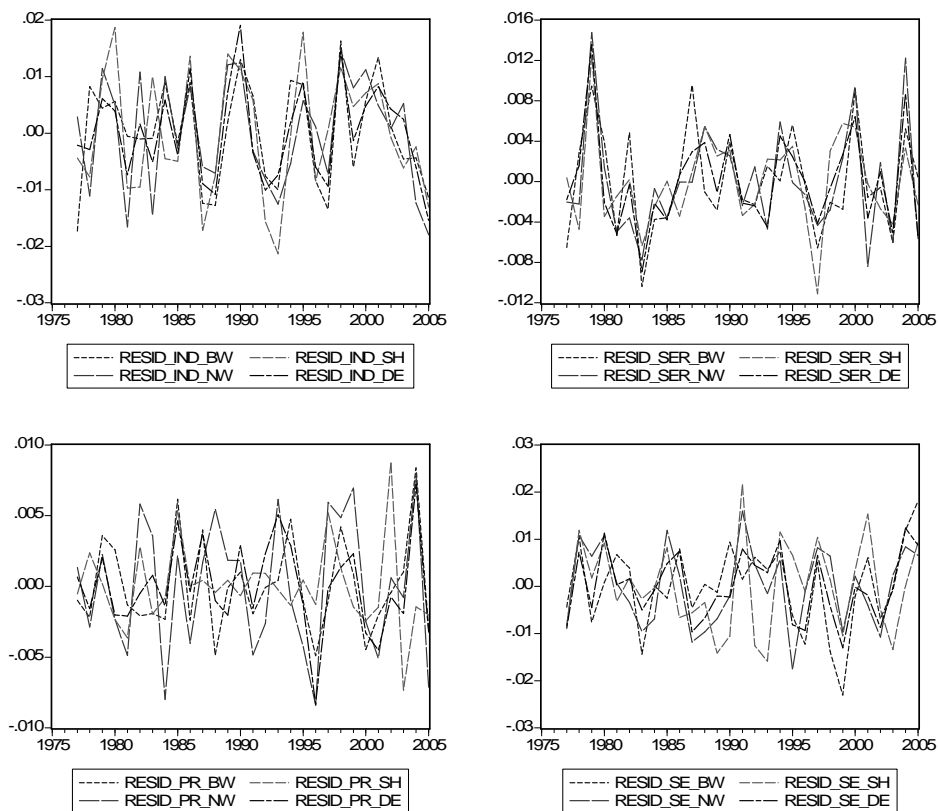
Statistical Classification of Economic Activities, selection from the complete List, NACE revision 1.1
NACE= Classification of Economic Activities in the European Community

NACE	Description
<i>R&D intensive industry branches</i>	
24	Manufacture of chemicals and chemical products
29	Manufacture of machinery and equipment n.e.c.
30	Manufacture of office machinery and computers
31	Manufacture of electrical machinery and apparatus n.e.c.
32	Manufacture of radio, television and communication equipment and apparatus
33	Manufacture of medical, precision and optical instruments, watches and clocks
34	Manufacture of motor vehicles, trailers and semi-trailers
35	Manufacture of other transport equipment
<i>Knowledge-intensive services</i>	
61	Water transport
62	Air transport
64	Post and telecommunications
65-67	Financial intermediation
79-74	Real estate, renting and business activities
80	Education
85	Health and social work
92	Recreational, cultural and sporting activities

source: http://www.fifoost.org/database/nace/nace-en_2002c.php [nomenclature in accordance with Eurostat]

A.3 Correlation matrix of OLS residuals

Figure A-1: OLS residuals of Baden-Württemberg (BW), North Rhine-Westphalia (NW), Schleswig Holstein (SH); Germany (DE)



The graphs show a similar development of the residuals, stronger in employees in industry and services, weaker in the participation rate and self-employment equation. In total, we find evidence for correlation between the Laender's residuals which indicates a preference for a "regional SUR" model.

Figure A-2: Correlation matrix of OLS residuals

Correlation Matrix EIND

	RESID_IND_BW	RESID_IND_NW	RESID_IND_SH	RESID_IND_DE
RESID_IND_BW	1,0000	0,5028	0,6499	0,8052
RESID_IND_NW	0,5028	1,0000	0,5851	0,8299
RESID_IND_SH	0,6499	0,5851	1,0000	0,7254
RESID_IND_DE	0,8052	0,8299	0,7254	1,0000

Correlation Matrix ESER

	RESID_SER_BW	RESID_SER_NW	RESID_SER_SH	RESID_SER_DE
RESID_SER_BW	1,0000	0,6012	0,5592	0,7431
RESID_SER_NW	0,6012	1,0000	0,6814	0,9094
RESID_SER_SH	0,5592	0,6814	1,0000	0,7372
RESID_SER_DE	0,7431	0,9094	0,7372	1,0000

Correlation Matrix PR

	RESID_PR_BW	RESID_PR_NW	RESID_PR_SH	RESID_PR_DE
RESID_PR_BW	1,0000	0,4591	0,0856	0,7634
RESID_PR_NW	0,4591	1,0000	0,2480	0,6825
RESID_PR_SH	0,0856	0,2480	1,0000	0,1967
RESID_PR_DE	0,7634	0,6825	0,1967	1,0000

Correlation Matrix SE

	RESID_SE_BW	RESID_SE_NW	RESID_SE_SH	RESID_SE_DE
RESID_SE_BW	1,0000	0,4330	0,2413	0,7551
RESID_SE_NW	0,4330	1,0000	0,4883	0,7910
RESID_SE_SH	0,2413	0,4883	1,0000	0,4316
RESID_SE_DE	0,7551	0,7910	0,4316	1,0000

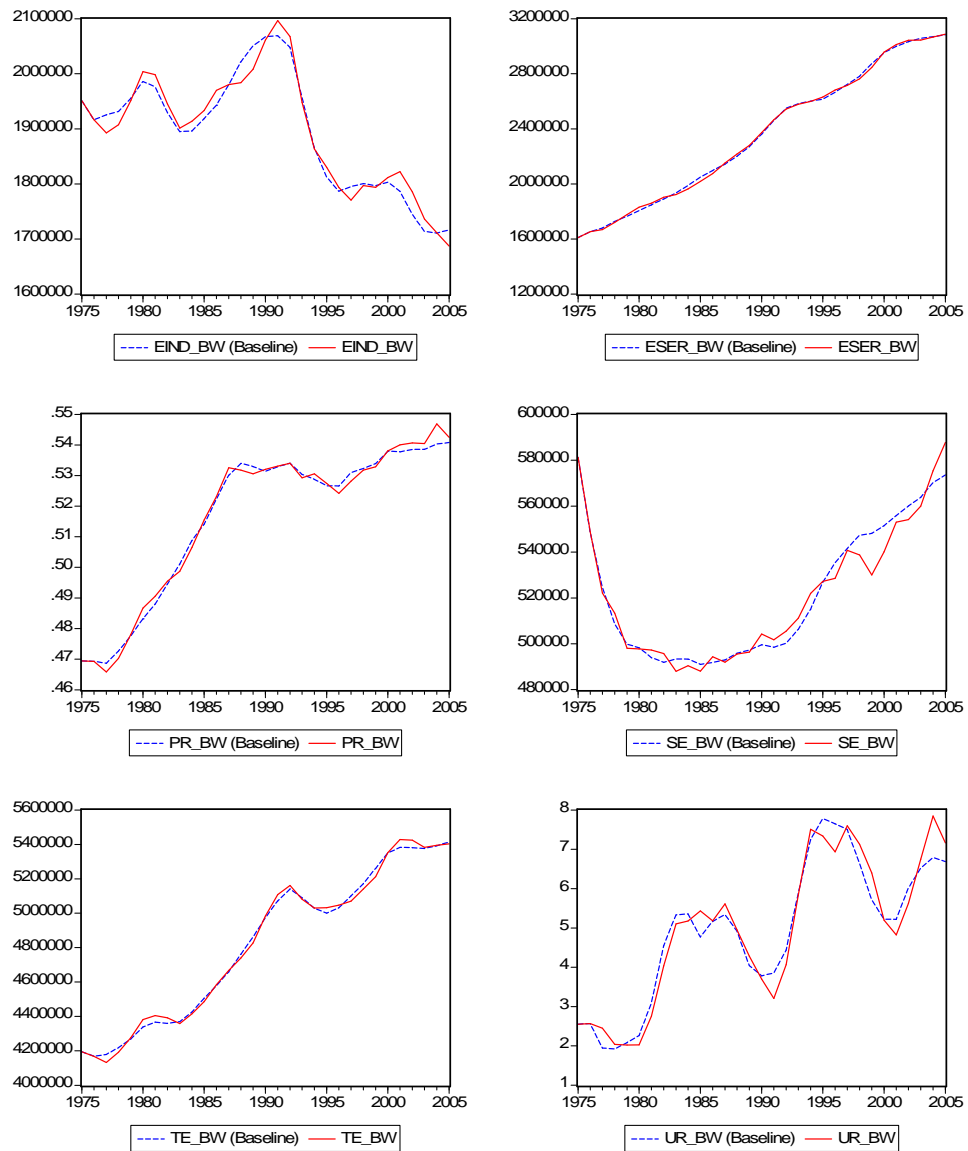
As noted in Chapter 5.2.2, most correlation coefficients outside the main diagonal are – in absolute terms- greater than 0.5. Hence, we find evidence for correlation between the Laender’s residuals that indicates a preference for a “regional SUR” model. In addition, we observe the strongest impact of North Rhine-Westphalia on the German average, followed by Baden-Württemberg and Schleswig-Holstein that reflects the size of the Laender.

A.4 Dynamic deterministic simulation

OLS results

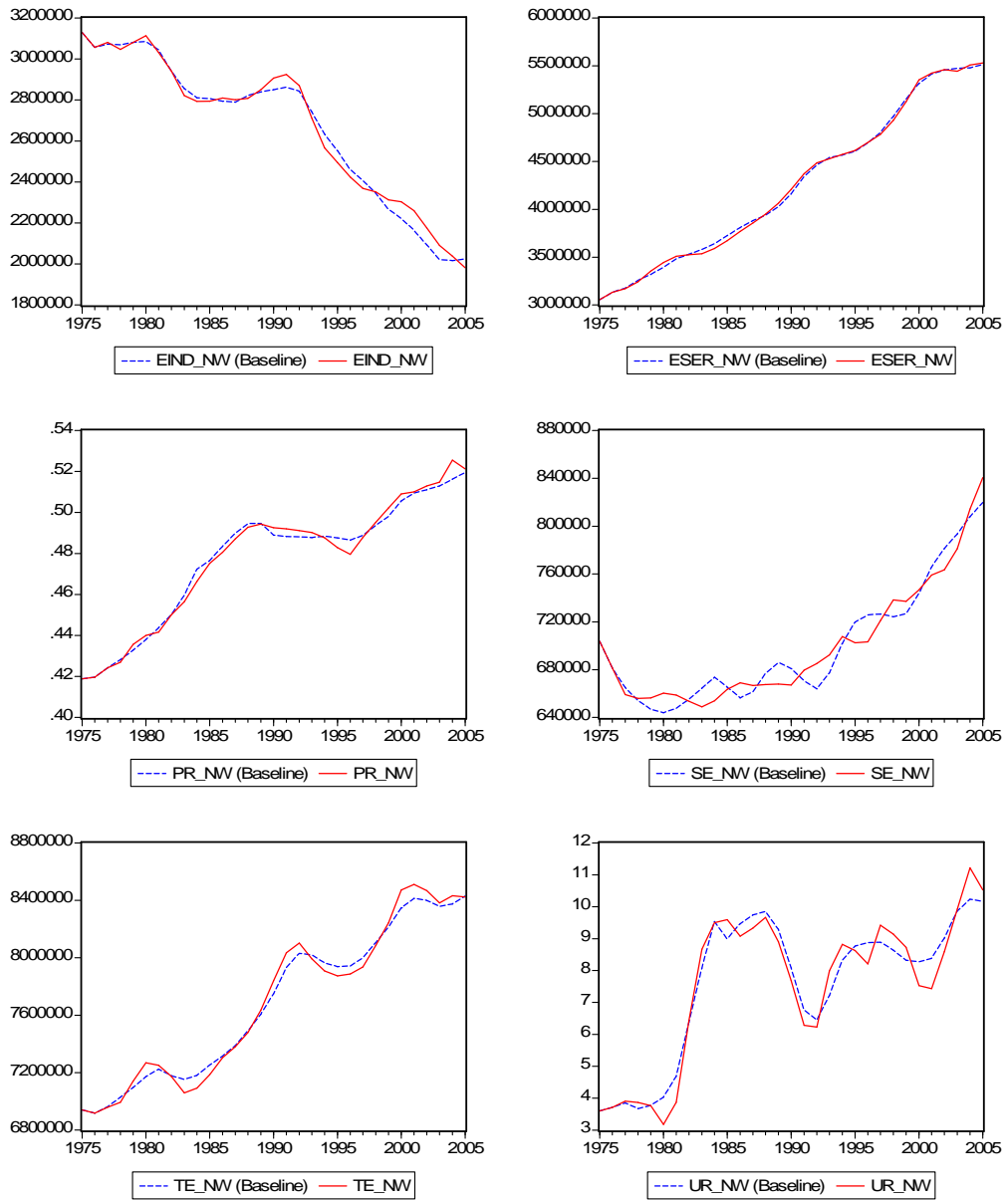
Baden-Württemberg

Figure A-3: Simulation results OLS, BW



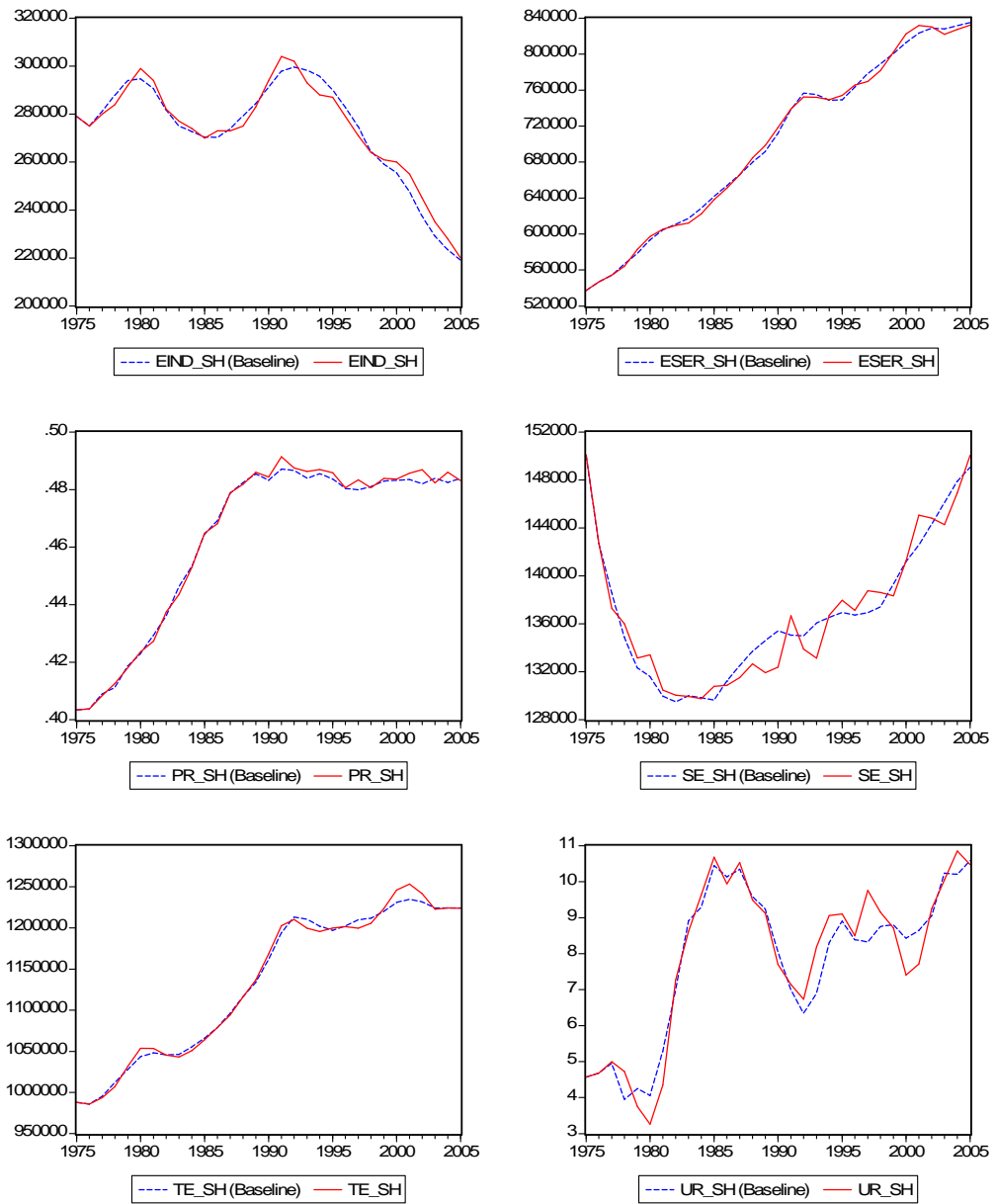
North Rhine-Westphalia

Figure A-4: Simulation results OLS, NW



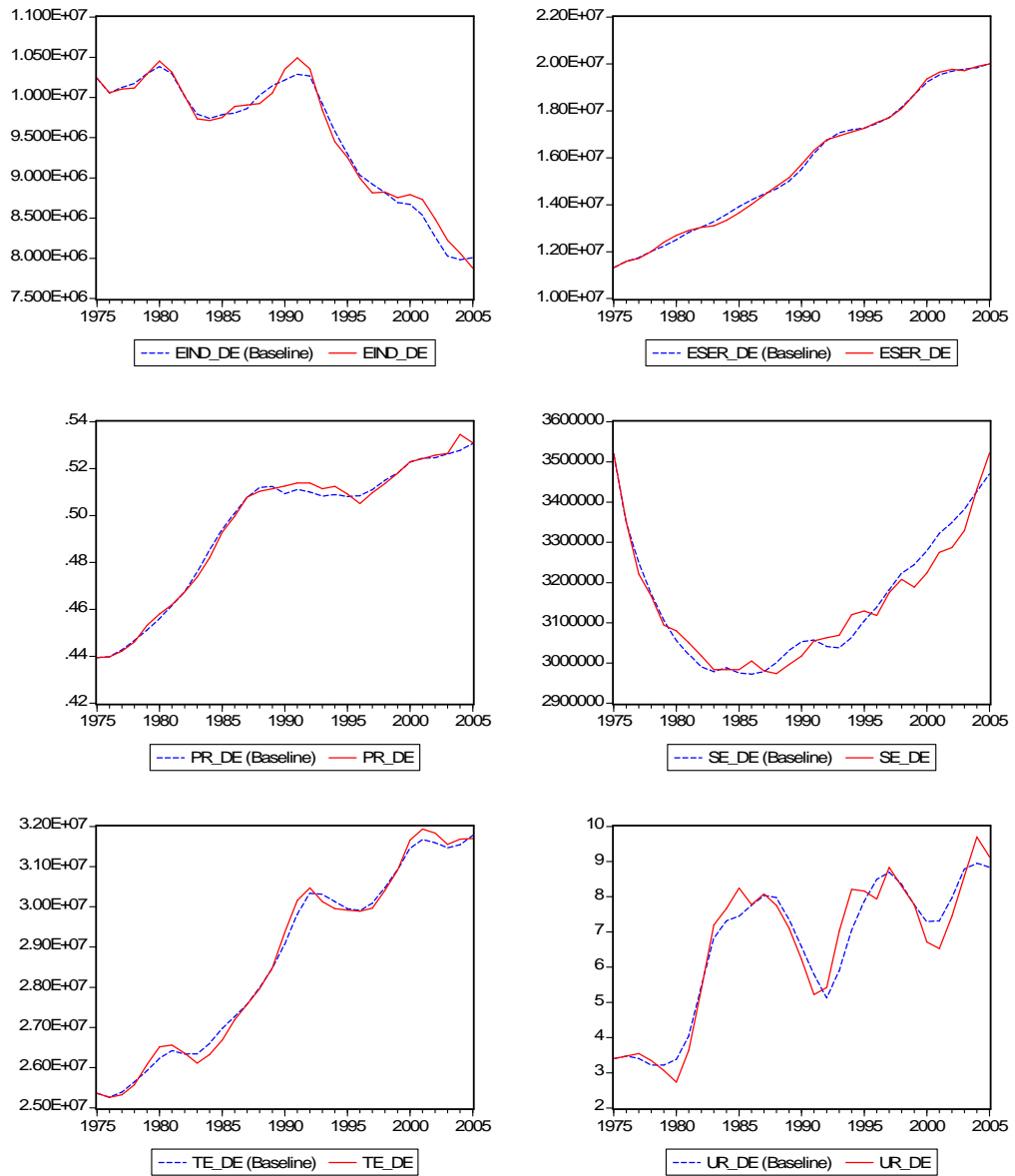
Schleswig-Holstein

Figure A-5: Simulation results OLS, SH



Germany (West)

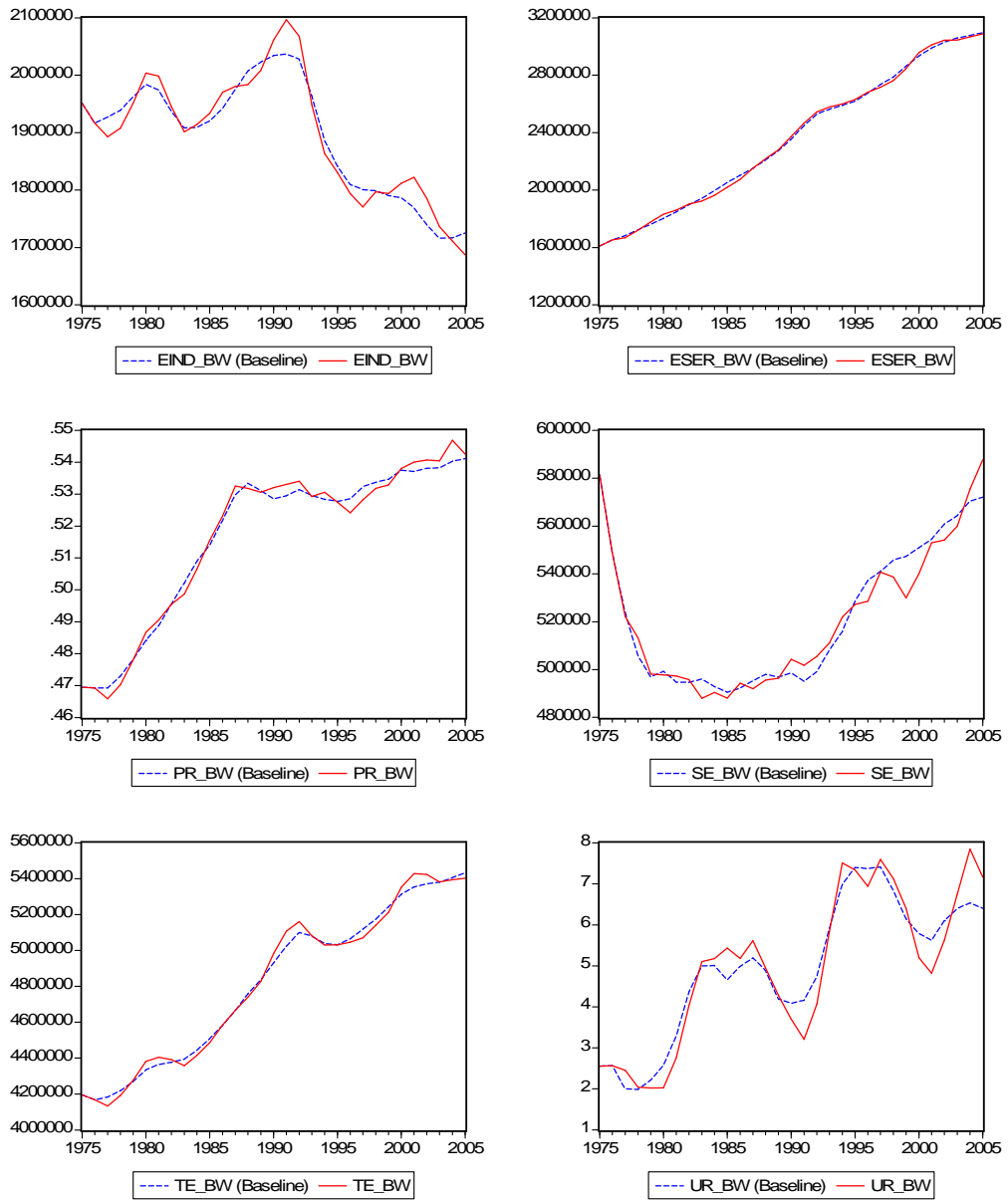
Figure A-6: Simulation results OLS, DE



SUR results

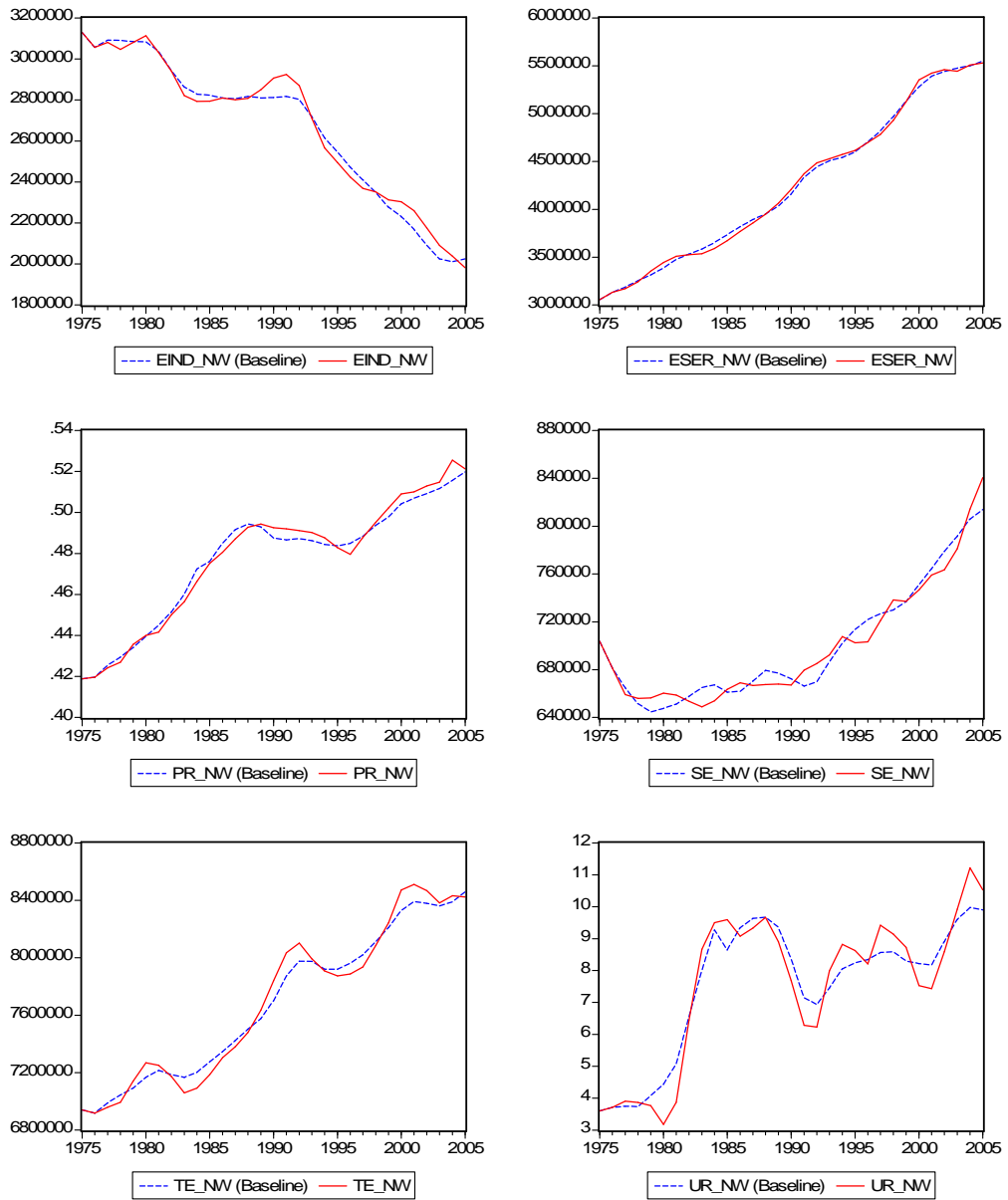
Baden-Württemberg

Figure A-7: Simulation results SUR, BW



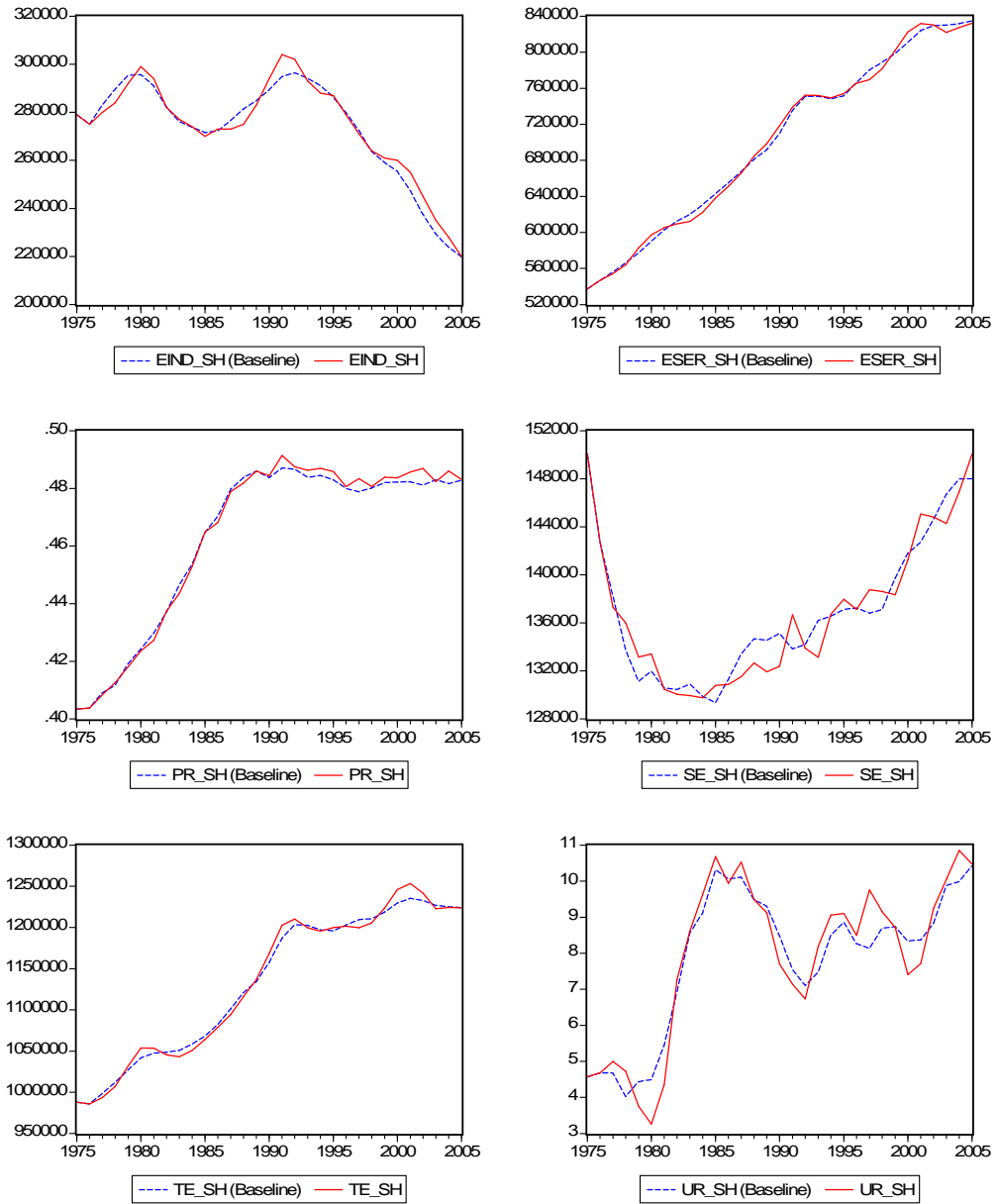
North Rhine-Westphalia

Figure A-8: Simulation results SUR, NW



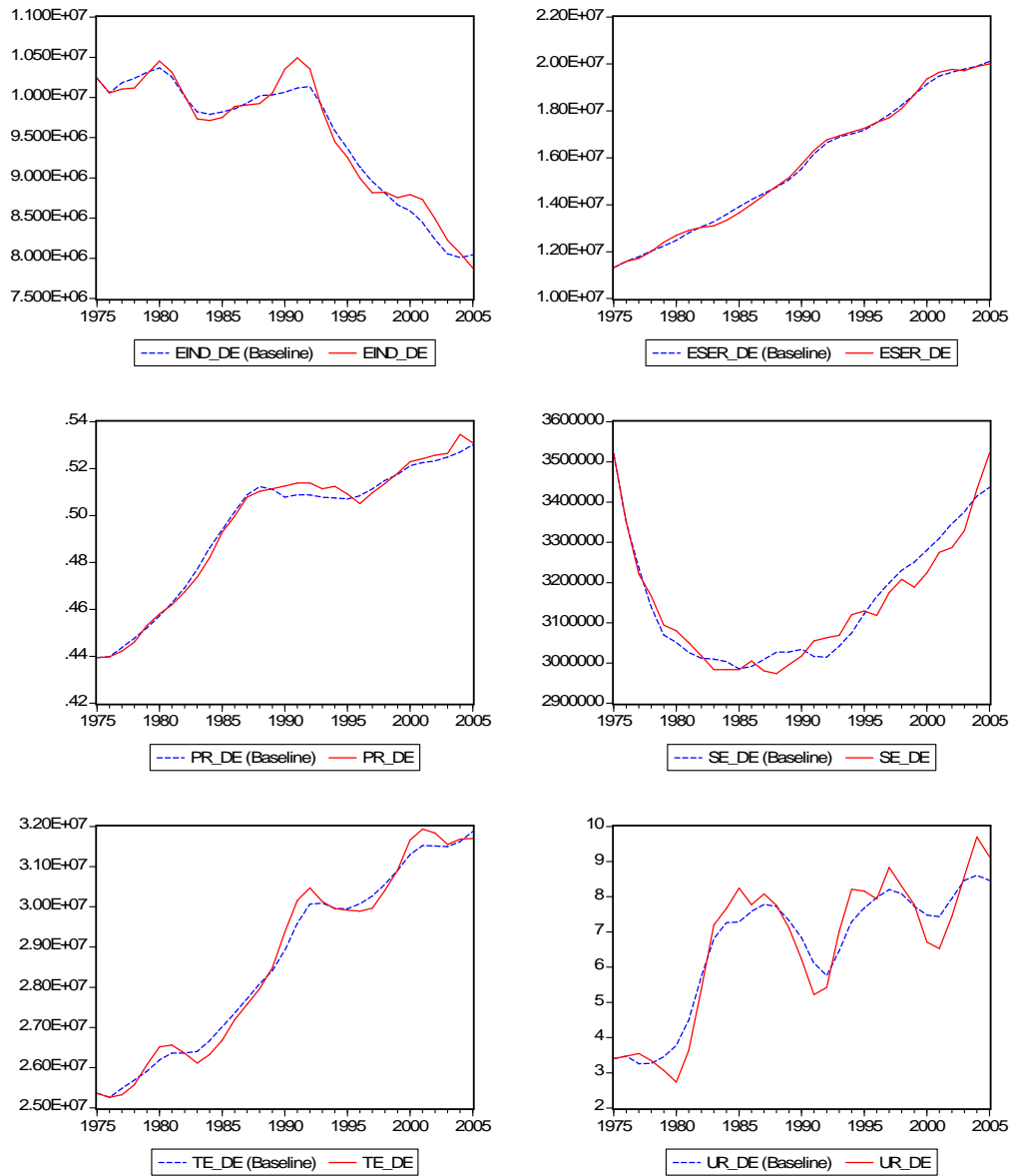
Schleswig-Holstein

Figure A-9: Simulation results SUR, SH



Germany (West)

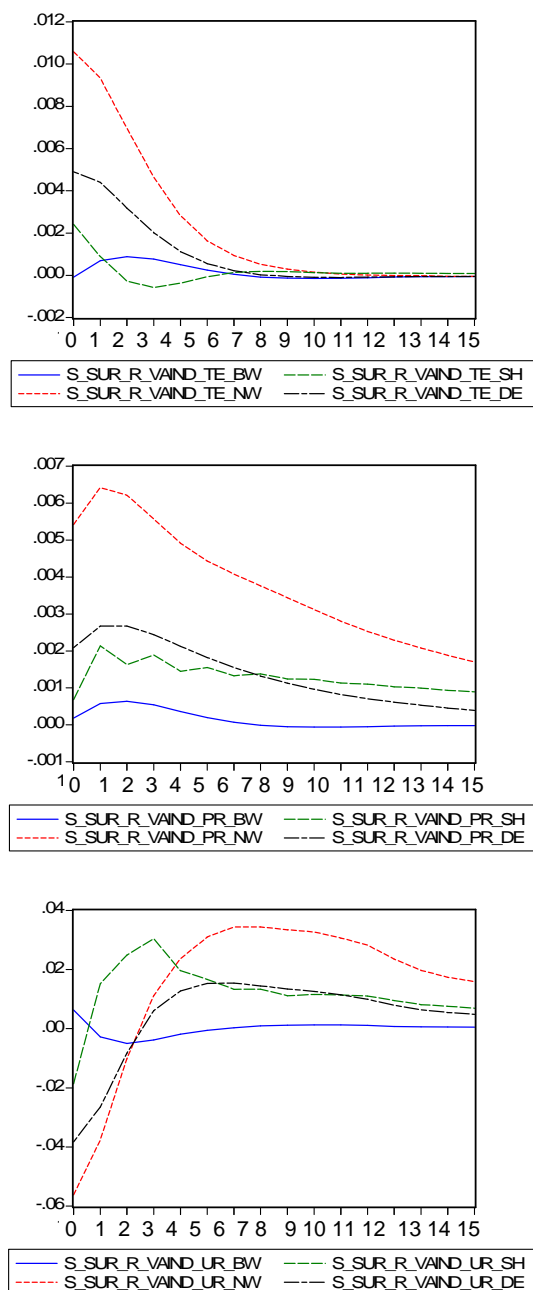
Figure A-10: Simulation results SUR, DE



A.5 Regional reactions to macroeconomic shocks (SUR)

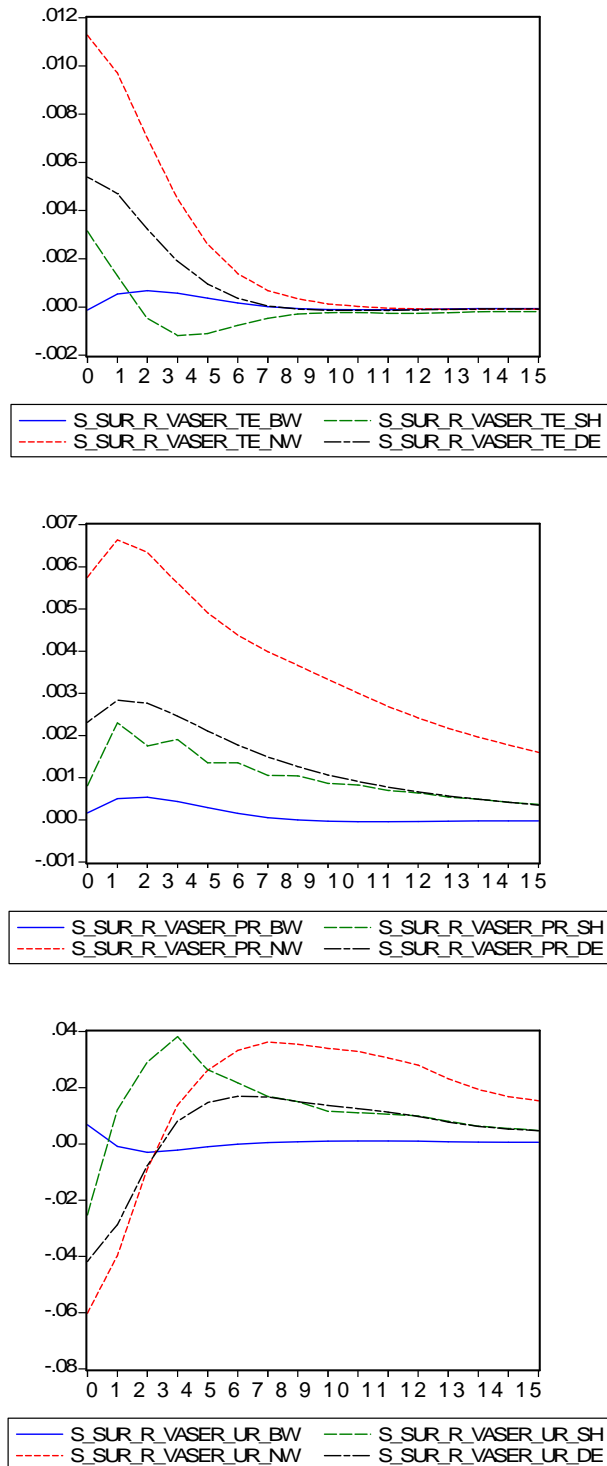
Total Employment, Participation Rate & Unemployment Rate response to a unit increase in Real Value Added Shock in Industry

Figure A-11: Reactions to a real value added shock in industry of BW, NW, SH, DE



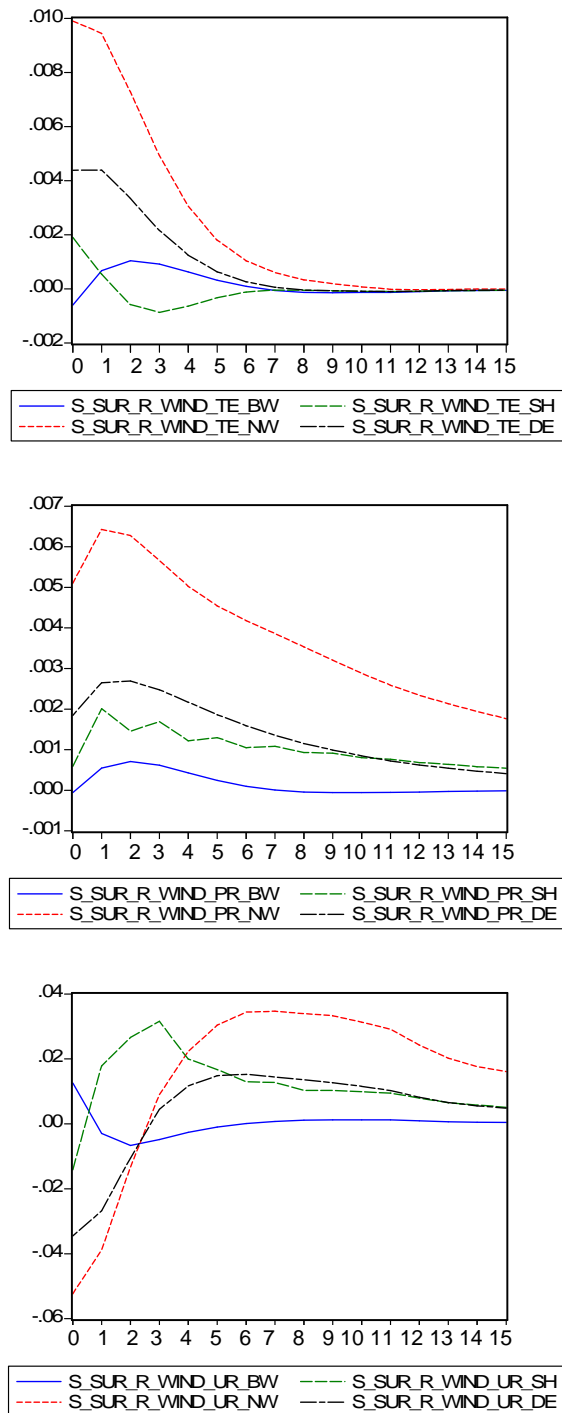
Total Employment, Participation Rate & Unemployment Rate response to a unit increase in Real Value Added Shock in SERVICES

Figure A-12: Reactions to a real value added shock in services of BW, NW, SH, DE



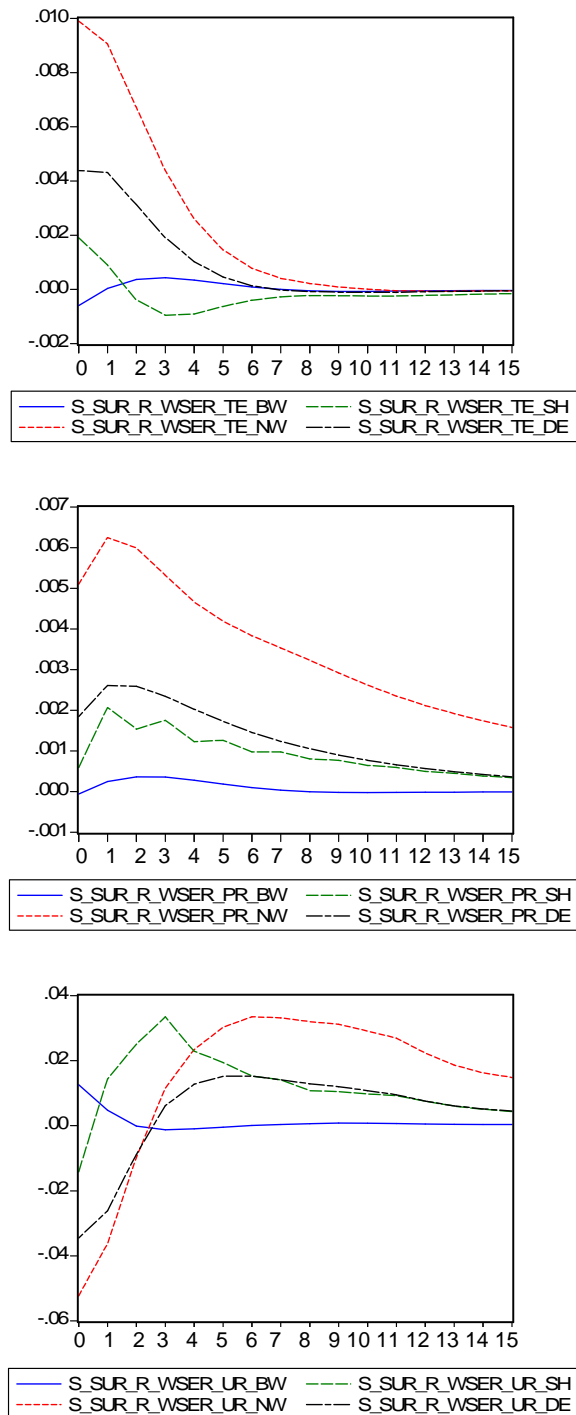
Total Employment, Participation Rate & Unemployment Rate response to a unit increase in Real Wages in INDustry

Figure A-13: Reactions to a real wages in industry shock of BW, NW, SH, DE



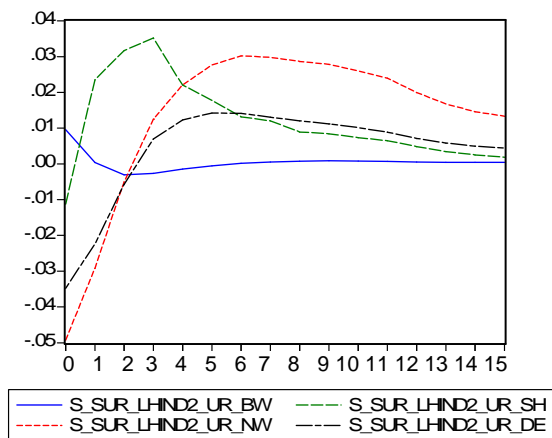
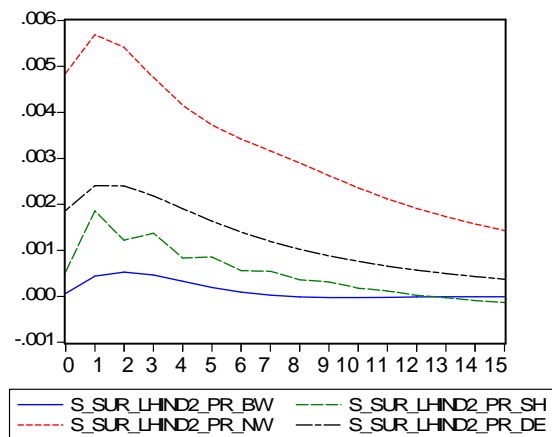
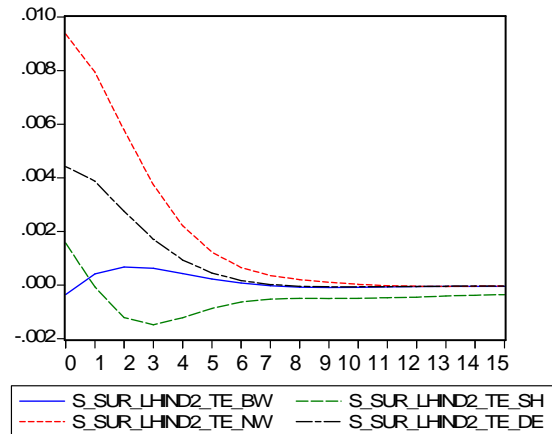
Total Employment, Participation Rate & Unemployment Rate response to a unit increase in Real Wages in Services

Figure A-14: Reactions to a real wages in services shock of BW, NW, SH, DE



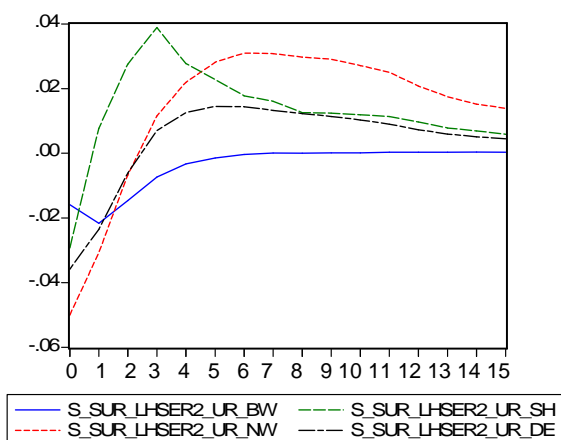
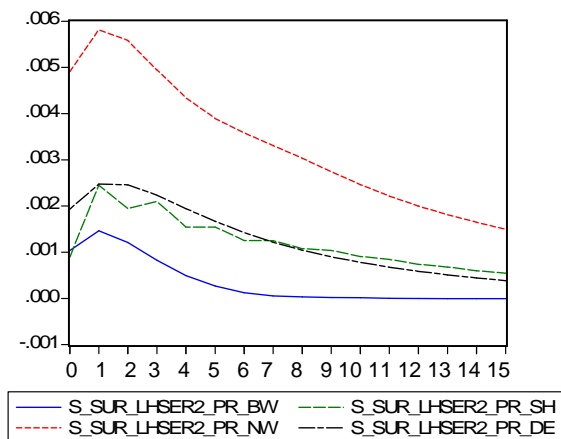
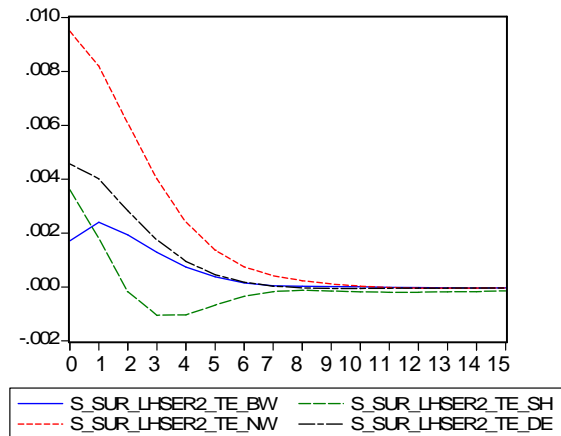
Total Employment, Participation Rate & Unemployment Rate response to a unit increase in Labour Hoarding in Industry

Figure A-15: Reactions to an innovation (productivity) shock in industry shock of BW, NW, SH, DE



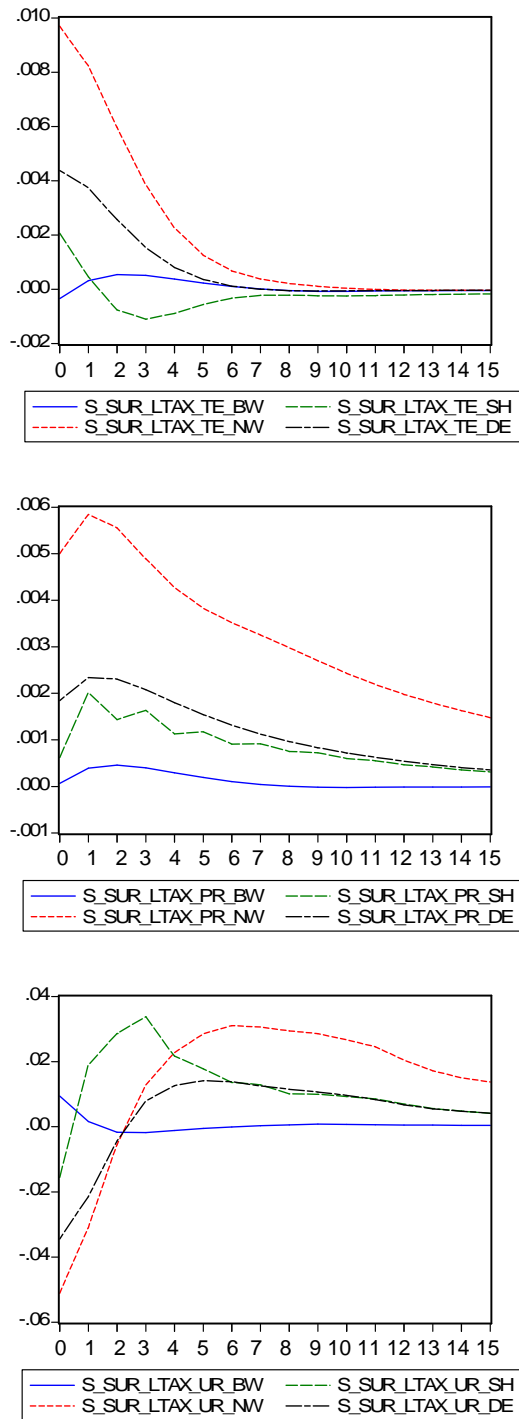
Total Employment, Participation Rate & Unemployment Rate response to a unit increase in Labour Hoarding in SERVICES

Figure A-16: Reactions to an innovation (productivity) shock in in services shock of BW, NW, SH, DE



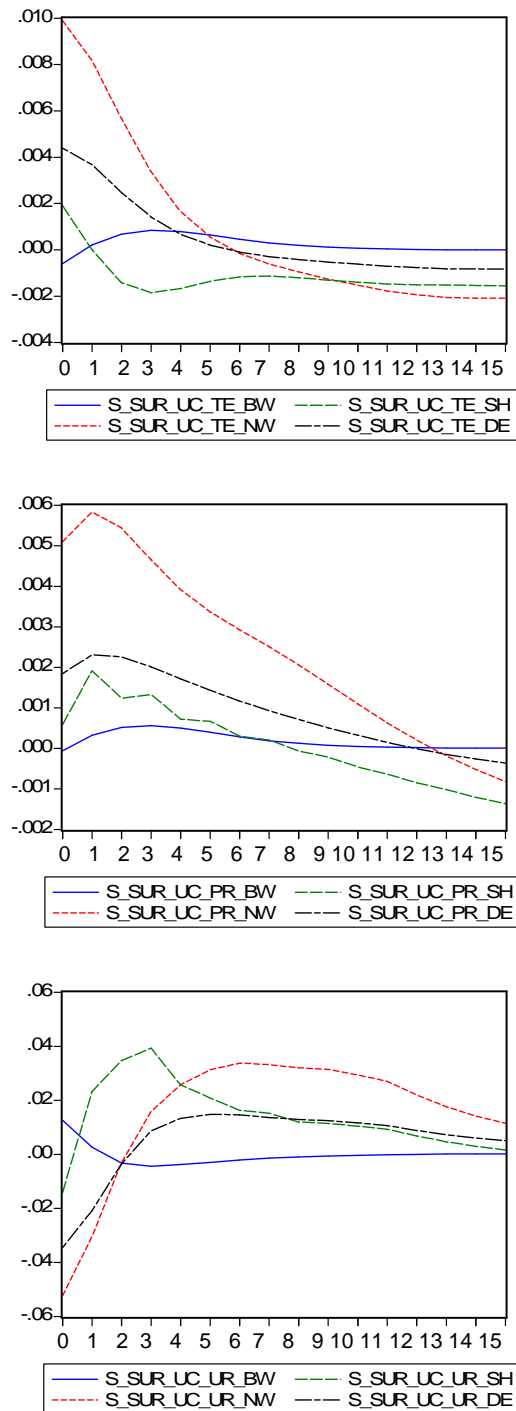
Total Employment, Participation Rate & Unemployment Rate response to a unit increase in Labour TAX

Figure A-17: Reactions to a shock in labour taxes of BW, NW, SH, DE



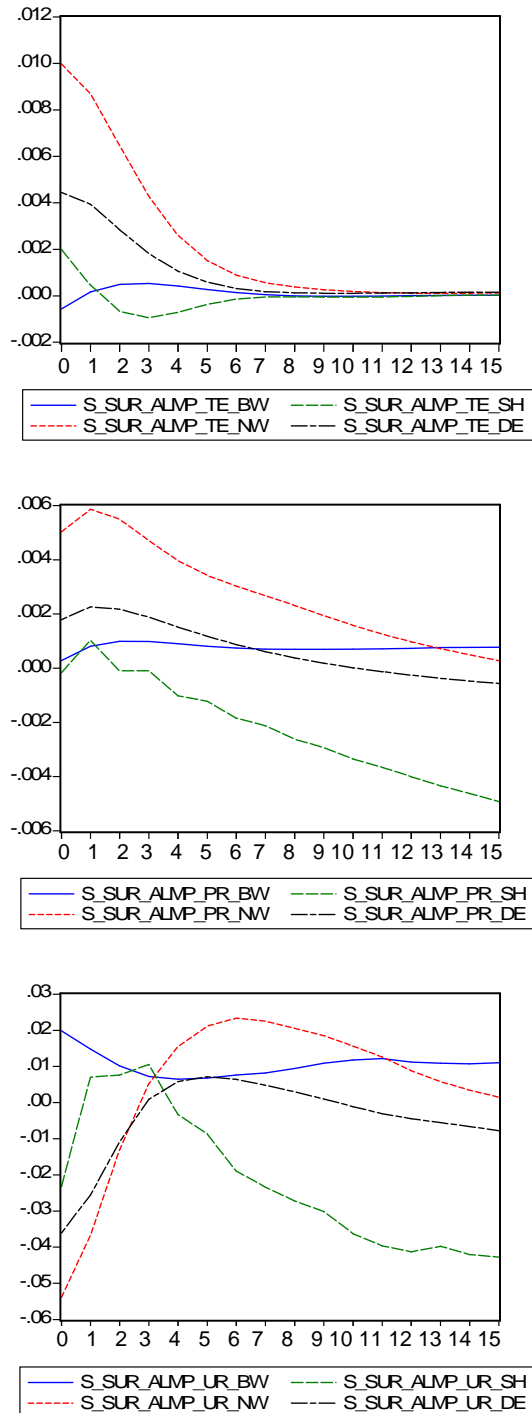
Total Employment, Participation Rate & Unemployment Rate response to a unit increase in Union Coverage

Figure A-18: Reactions to a shock in union coverage of BW, NW, SH, DE



Total Employment, Participation Rate & Unemployment Rate response to a unit increase in expenditure of Active Labour Market Policy

Figure A-19: Reactions to a shock in active labour market policy of BW, NW, SH, DE



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